METAL
Progress
December 1924

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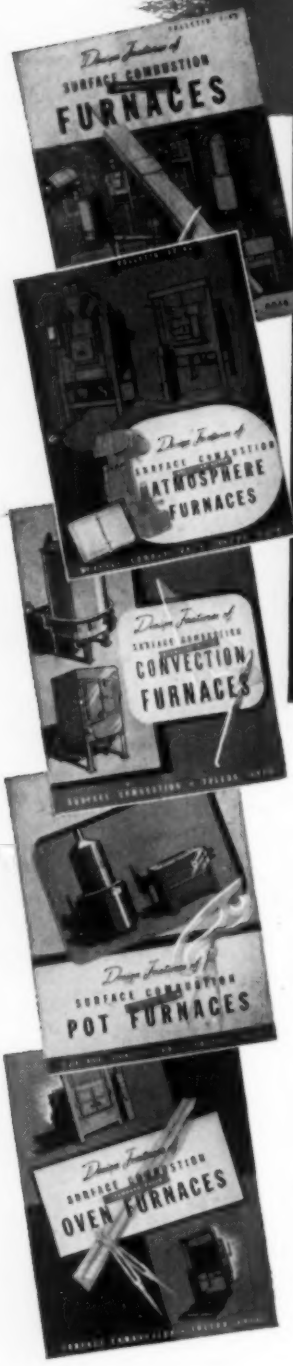

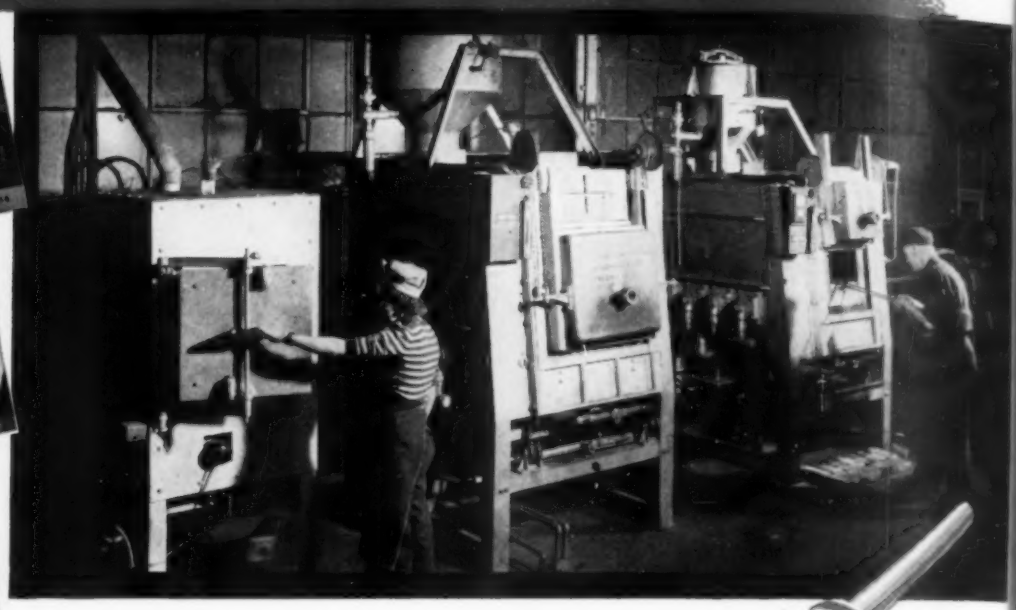

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RYERSON STEEL-SERVICE

American Tin Supplies and Wartime Consumption

y Erwin Vogelsang
irector
n, Lead & Zinc Division
ar Production Board

The ⊖ was fortunate in having the one man who has been continuously in charge of the tin supply since General Preference Order M-43 was issued on Dec. 17, 1941 to lead a discussion of "Tin, Tin Alloys, Tin Coatings" at the Metal Congress in Cleveland, Oct. 17. Mr. Vogelsang's analysis of the situation which faces metal consumers deserves the closest scrutiny by technicians and public alike, for he demonstrates that our dwindling stockpile cannot eke out the emergency if we relax our efforts in conservation and scrap collection.

World War I, as in the present war, tin was one of the most important metals. During the o decades that elapsed between World War I d the present conflict, numerous plans were oposed to insure that the United States would protected in the case of another great war. It s, however, impossible to secure enough Con-essional support to enable any of these plans to carried out.

In September 1939, when war in Europe oke out, the United States again found herself h no domestic tin production, with no sub-ntial stocks, with her industries, which con-me half of the world's tin output, dependent irely on purchases of tin produced by foreign erests half way around the world. Late in 9, the Congress passed legislation to provide United States with a modest stockpile of ategic and critical metals and minerals. Unfor-ately, the fund set aside by the Congress was so small that even if there had not been competition for shipping space and if it had been possible to expand production immediately, only a fraction of the tin needed could have been acquired.

In June 1940, with the formation of the Advisory Committee to the Council for National Defense, vigorous steps were taken to rectify the *laissez faire* of two decades. The tin problem was given especial attention, and agreements were made with the International Tin Committee to expand tin production throughout the world. Efforts were made to purchase pig tin for governmental account, while large industrial consumers, such as tin plate makers, were also encouraged to purchase tin in all parts of the world. Studies were put under way regarding the feasibility of again establishing a tin smelting industry in this country. After the decision to build such a smelter, and pending the selection of the site and the operator of this governmental plant, large contracts were negotiated for tin concentrates to supply this smelter.

Tin was placed under General Priorities Regulation in August, 1941 and under full allocation and import control by the issuance of General Preference Order M-43 on December 17, 1941.

Shortly after the United States entered the war in December, 1941, we had succeeded in securing for governmental account 50,039 long tons of pig tin and 23,245 long tons of tin in concentrates from the Far East and Bolivia.* During the first quarter of 1942, a substantial

*EDITOR'S NOTE — Our annual consumption in a prosperous year had been on the order of 75,000 short tons of new tin, plus 25,000 short tons of secondary metal recovered from scrap.

tonnage of tin, both as pig tin and in the form of concentrates, arrived in the United States from the Far East.

Although we have had very little loss from submarine activity, it must not be thought that we have been able to import all of our requirements. Actually, the peak of United States' supplies was attained early in 1942, and since that time we have steadily and inexorably dipped into this stock.

It has been solely through the far-sightedness of both government and industry (especially the tin plate industry) in accumulating considerable stocks of tin and through drastic conservation and limitation orders directly affecting the use of tin, such as M-72 (Tin Scrap), M-21e (Tin and Terne Plate, Terne Metal), M-81 (Tin and Terne Plate on Cans), M-86 and M-86a (Canned Foods), M-115 (Collapsible Tubes) and M-104 (Tin and Terne Plate Caps), that any reasonable balance between supply and requirements could be maintained.

It will appear from later figures that if we have any tin left at all it is due to the coordinated activities of specialists within the Government and in the tin consuming industries working on recovery, conservation and substitution.

War Stocks

The statistics presented later in this paper cover the 2½-year period of the war, beginning January 1, 1942 through June 30, 1944, during which time no adequate or comprehensive data on tin have been available to the public. The unit of measure for all figures, unless otherwise specified, is long tons of contained tin.

The stock figures presented herewith consist of pig tin and tin contained in government-owned concentrates, as well as private-owned stocks of pig tin and other tin material such as bar tin, anodes, powder, alloy scrap, and tin in process at manufacturing plants. Private-owned stocks include tin at consuming plants and at detinning plants, together with stocks in the hands of dealers, jobbers and warehouses. Classified as private stocks are those at navy yards and depots (except the Navy's reserve stock). Stocks of tin plate scrap, old cans, and alloy scrap in the hands of scrap dealers have been excluded.

Interpretation of the figures representing government-owned stocks must be qualified by the following facts: First, stocks of concentrates include an estimated amount of intermediate products such as the tin content of concentrate charged into the furnaces but not yet emerged as metal, and as tin in slags and flue dust ultimately recoverable as tin. Second, the stocks of government-owned pig tin include about 10,000 to owned by the U. S. Treasury and about 2000 to of U. S. Navy reserve stock, neither of which available for distribution by the Tin, Lead a Zinc Division, W.P.B.

At this point I had a table showing the brea down of the government and private stocks. T table, however, has been deleted by the Ar censors. I am permitted to give you the combin government and private stocks for January 1942, namely 143,000 tons, and July 1, 19 123,000 tons. A further decrease in this lat figure of about 10,000 tons before the end of t year is estimated. The over-all stocks of tin ha not dropped this current year as badly as fear because of the fortunate purchase in 1943 o substantial tonnage of Patino concentrates wh was originally destined for England. This t nage arrived in the U. S. this year and reflects greater amount from Bolivia than is customa

Dwindling Stockpile

This stockpile of tin is in a different categ from the wartime stockpiles of other metals minerals. Of the government stocks of pig t the Navy's stocks are not available to indus except for special naval requirements, and w drawals from the stocks of the Treasury Procu ment Division can be made only by presiden authority. Therefore industry, whose pig stocks are almost scraping bottom at the pres time, has available only the Metals Reserve sto together with current arrivals from the Belg Congo and current production from the Longh smelter in Texas. Although to the uninitiated tin stockpile might appear more than ample the present emergency, a careful examination the figures will show otherwise.

Immediately *after* this war, much of the material of the world as well as domestic prod tion, if any, plus the possible release of surplu not needed for post-war governmental stockp will be available to industry. However, such not the case with tin. When the war with Ja is ended, it will take some years before the g number of dredges are rebuilt or replaced before the tin smelters are once again functio normally. Thus, for a considerable length of t there will trickle into the world markets f the Far East only that tin which can be produ by hand from mining or sluicing operation Malaya, Siam and Netherlands East Indies smelted in temporary plants. Contrary to s opinion, there are no indications that Japan built up huge reserves of pig tin from t

mines. A very small tonnage of tin will continue to be available from China.

We may therefore expect that tin will be under some form of control for a period after hostilities cease, if we are to avoid chaotic conditions in the supply, price and demand for this metal. In the meantime the post-war demands, both here and in the liberated countries, for tin to be used in tinplate for containers, for plant rehabilitation in the form of babbits, bronzes, solders, and for current consumption, will impose a terrific strain upon the small supplies of the United States and Great Britain.

Sources of the Metal

Pig Tin — The United States has been dependent upon foreign sources for its supply of new tin. When the Malay Peninsula, the Netherlands East Indies and other Far Eastern sources were overrun by the Japanese, the only major sources available to all the United Nations were South America, Africa, and China. Immediately following the outbreak of hostilities, a considerable amount of Far Eastern concentrate and pig tin was in transit to the United States.

In the 2½ years since then, our major source of imported refined tin has been the Belgian Congo. Smaller amounts have been received from China (which at all times is a dubious supplier due to the difficulties of transportation via the Burma road and by air), and from a few miscellaneous sources.

Tin Concentrates — The government smelter has been dependent chiefly on Bolivia for its supply of concentrate (ore). However, additional amounts have been obtained from the Belgian Congo, French Cameroons and one or two other sources. Concentrates from the Belgian Congo first arrived in 1943, when its production exceeded the capacity of the local smelters. These alluvial tin concentrates, of the highest grade, are in every way comparable with receipts from the Netherlands East Indies prior to the Japanese occupation. They average between 72 and 75% tin, and because of their extreme purity are exceptionally easy to treat. (It is expected our tin supply from the Belgian Congo will decline after the war, since the natives of the Belgian Congo will again be attracted to gold mining operations in the post-war period.)

Practically all of the rest of our ore supply is Bolivian tin concentrate of innumerable grades from dozens of different properties. These concentrates contain impurities such as copper, lead, zinc, iron, bismuth, arsenic, antimony and sulphur, and great skill is needed in the sampling, treatment and blending of these concentrates in order that the smelter feed will be suitable for efficient and economic operation. In consequence of the necessary preliminary treatment and the later blending of this material, the smelter's stockpiles have to be many times greater than would be the case with Belgian Congo, Netherlands East Indian or similar tin concentrates.

In Bolivia, contracts were negotiated for the output of all the tin mines other than the Patino group, the latter being under contract to ship to British smelters. Our Bolivian tin concentrates which come from lode mines are for the most part low grade, and their inability to furnish a clean high grade concentrate has necessitated building at Texas City a plant to beneficiate these imports through concentration, roasting and leaching before delivery to the tin smelter.

(Bolivia probably has passed its peak as a source of tin, and while new treatment processes may result in higher recovery of the metal contained in Bolivian ores, these methods will only serve to make less precipitous the decline of production from that country.)

Here another table giving the breakdown of concentrates and pig tin imports has been deleted, but I can give you the totals:

For 1942	56,000 long tons
For 1943	38,000
and for 1944 we estimate	50,000

Domestic Mine Production — For about 60 years efforts have been made to develop a domestic tin mining industry. Large sums of money were lost in California and South Dakota, and lesser amounts were sunk in Texas, the Carolinas, Virginia, Alabama and other states.

During the last war, numerous deposits and localities where the occurrence of tin was reported were examined without success. Sporadically in the intervening 20 years, ore deposits of tin were reported, but no regular production ensued. Since the outbreak of the present war and in cooperation with the Geological Survey, the Bureau of Mines and other federal and state agencies, the Tin Division, W.P.B., has encouraged the search for tin deposits. The results to date confirm the opinion of experts, to-wit, no commercial deposits of tin are known to exist, and the likelihood of ever discovering such deposits appears remote.

Bureau of Mines reports the mine production in the United States as 95 long tons of tin content in 1938, 34 in 1939, 49 in 1940, 56 in 1941, 6 in 1942 and 8 long tons in 1943.

Domestic Secondary Tin — Since the mine production of tin in the United States is almost non-existent, domestic new supply consists chiefly of secondary pig tin recovered from tin plate

scrap and from used cans. In addition, a large quantity of tin is recovered from old tin-base, lead-base, and copper-base alloy scrap consumed in the production of additional alloys.*

Additional Recovery — With the prohibition of the use of tin oxide for most purposes, arrangements were made to convert these now surplus stocks into pig tin. In addition, tin in stocks of jewelers' metal, britannia, pewter, and similar alloys was turned to more vital needs, since the use of tin in these products was prohibited. The jewelers' metal was suitable in the manufacture of genuine babbitt metal without conversion into pig tin. Excess stocks of type metal were treated for the recovery of tin, while tin anodes, used for tin plating, were collected and remelted into pig tin. Highly successful results were obtained from the program instituted for the collection of used collapsible tubes, many of which were of pure tin. One of the most difficult undertakings was the collection of old tin cans (a national campaign which is still under way) notwithstanding the difficulties in collection due to labor, gasoline and rubber shortages.

All these programs were superimposed upon the regular industrial salvage of tin, a highly organized industry which reclaims tin in alloys or makes pig tin from the can-making plants' tin plate scrap.

Conservation and Substitution

Concurrently with these efforts to secure pig tin or tin in alloys from additional and heretofore untapped sources, an extensive series of conservation activities was undertaken. Low tin babbitts and solders were found thoroughly satisfactory for many uses hitherto monopolized by genuine babbitt and high tin solders. Collapsible tubes coated with tin, or with low or no tin content metal were put into production on a large scale. The steel industry sponsored the greatest of all conservation devices in its development of the electroplating of continuous wide sheets of steel. A tremendous tonnage of electrolytic plate is now produced with a coating of tin approximately half as thick as hot dipped plate, but which, because of its dense, uniform coating, has been found suitable for most tin plate applications. This development, while of great wartime importance, gives every indication of becoming the major post-war method of tin plate production.

American Consumption

As a result of the various conservation and substitution measures, all classes of tin consumption, with but two exceptions, declined from pre-war levels. These two were brass and bronze and babbitt. Tin consumed in brass and bronze rose from a pre-war level of about 6000 long tons per annum to more than 30,000 in the war years.

After reaching the all-time record of consumption of 134,695 long tons in 1941 (according to the Bureau of Mines), consumption of tin dropped to 85,687 long tons during 1942 and to 80,066 long tons in 1943. The current rate in 1944 is slightly in excess of either of the latter two years.

A comparison of consumption by class of product during 1942, 1943 and the first six months of 1944 has been compiled by the Tin, Lead and Zinc Division, W.P.B., and is shown herewith.

Consumption of Tin and Tin in Alloys
(Long Tons)

Item	1942	1943	Jan.-June, 1944
Tin and terneplate	29,404	22,643	11,851
Brass and bronze	27,655	28,839	17,597
Solder	13,924	13,098	6,593
Babbitt	6,099	7,381	4,448
Tinning	3,015	2,517	1,667
Collapsible tubes	1,099	602	256
Foil	576	371	206
Type metal	1,153	550	417
Chemicals	246	133	29
Pipe and tubing	161	117	103
Other and unclassified (includes exports and re-exports of pig tin)	2,764	5,589	1,507
Total	86,096	81,840	44,668

A table giving the detailed United States tin supply-consumption summary has been deleted but I am permitted to say that the expected deficit for the year 1944 will be between 12,000 and 13,000 long tons.

Domestic Tin Smelting

Since 1923 there had been no domestic tin smelting industry of any importance in the United States. However, when it became apparent in 1940 that our regular sources of tin supply were threatened, plans were made for the construction

*Editor's Note — At this point a table showing the new supply of secondary tin recovered from tinplate scrap, old tin cans, bronzes, solders and the like was deleted by the censor. It is obvious from the other figures passed by him, here and elsewhere, that this amount is what is saving the day for the tin consumer, and totals about 35,000 long tons, or 60% more than in the normally prosperous pre-war year quoted in the preceding footnote.

of a government-owned tin smelter. After consideration it was decided to locate the plant at Texas City, Texas. Under the supervision of the Tin Processing Corp., construction was begun in October of 1941, and smelting operations began in April of 1942.

Original plans called for an annual capacity of 18,000 tons of fine tin to be produced from Bolivian ores. The smelter was later enlarged to a capacity of 52,000 tons of tin per year — 30,000 tons from Bolivian ores and 22,000 tons from high grade alluvial ores. During the latter part of 1942 further extensions were authorized, and the present capacity is between 70,000 and 90,000 tons per year depending on the grade of ore available. It is not expected that operation will ever be at 100% of capacity, but at the time this large capacity was authorized, there was a possibility that the British smelters would be bombed out of existence; consequently provision was made to smelt the entire United Nations' supply of concentrates, if necessary.

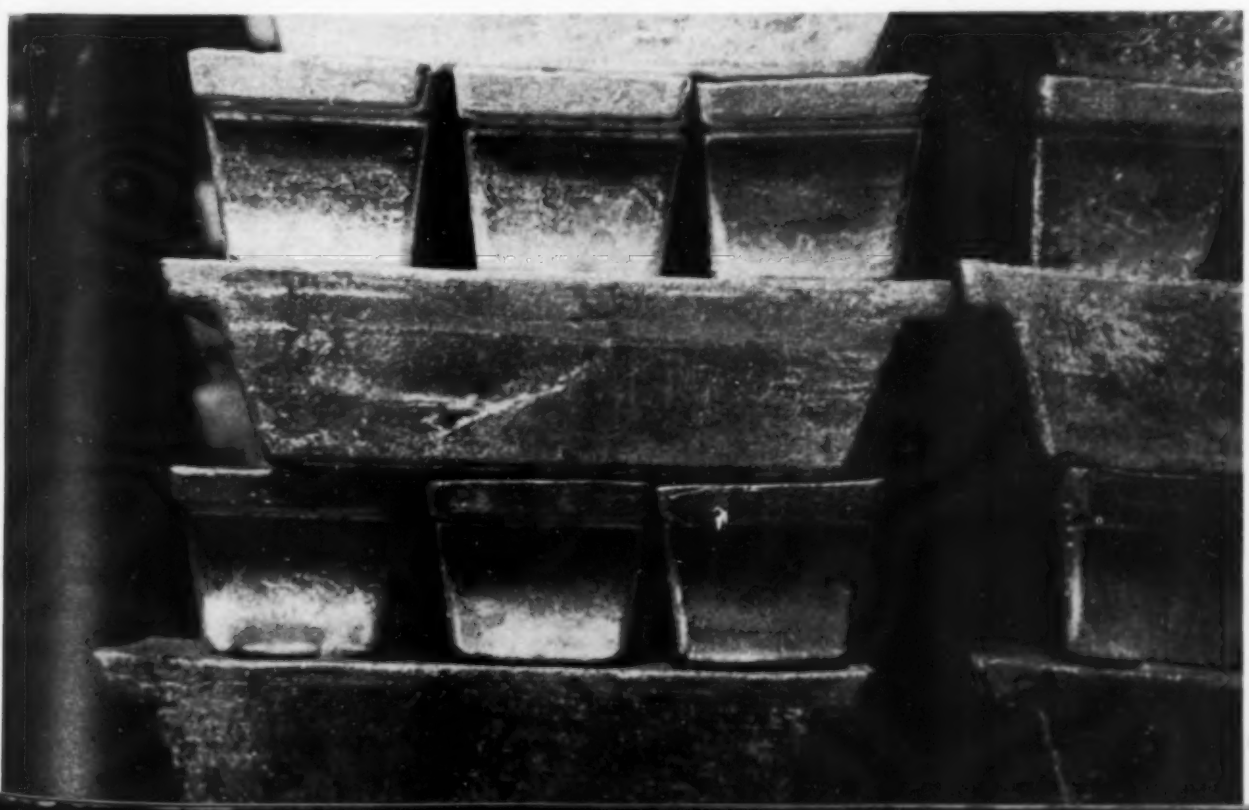
The current rate of production from this smelter is just over 30,000 long tons per year, which is approximately equal to the new supply of concentrate now available. Between the date when the smelter began operations, in April of 1942, through December of that year, 15,695 long tons were produced. The production in 1943 amounted to 20,727 tons, while that for the first six months of 1944 totaled 14,534 long tons.

Several grades of tin are produced, and the "Longhorn" brands are rapidly becoming well known throughout the tin consuming industry. The major portion of the tin produced is of Grade A specification. During the first six months of 1944 about 90% of the production was of this highest grade.

Future American Supplies

In pre-war years the American public evinced some interest in our situation with regard to tin supplies. The Congress held exhaustive hearings in 1935 on this subject. It is apparent that the American public sees no good reason why we should not have a domestic tin smelting industry, for we possess the requisite equipment and knowledge. That work of a superior metallurgical caliber is now being done at Texas City is shown by the making of the highest grade of tin from the lowest grade and most complex of concentrates, solely by fire refining.

The smelter is currently receiving tin concentrates from abroad, but in time we must face the inevitable decision as to whether the smelter should be sold to private interests, maintained by the government, or dismantled. If either of the first two alternatives is accepted, then steps must soon be taken to assure the smelter of a steady flow of tin concentrates. Because of pre-war international agreements and political and commercial control, the flow of tin concentrates to existing smelting centers was closely controlled. Unless changes are made in restrictive laws and corporate controls, there appears little likelihood that Americans can secure a sufficient supply of raw material to feed a domestic tin smelter, notwithstanding the oft-repeated statements in high places that America needs a domestic tin smelting industry and ample supply of tin concentrates to free it from foreign control.



A Study of Several Kinds of High Strength Plate Steel

By George F. Comstock
Metallurgist
Titanium Alloy Mfg. Co.
Niagara Falls, N. Y.

Titanium has been substituted very successfully for the strategic vanadium in the high strength weldable steel plate used by the U. S. Navy for hull construction. This article describes some extensive tests on 19 laboratory heats of these two and other types of steel that have been used or suggested for high strength plate, and will be supplemented by a similar report on some commercial heats of the important ones.

FOR MANY YEARS the United States Navy has been specifying for the hulls of many warships plate steel of higher strength than the usual plain, low carbon steel used for commercial vessels, in order to save weight. At first, most of these ships were riveted, and somewhat less ductility than is found in carbon steel could be tolerated. The kind of high strength plates favored by the Navy originally was a manganese-vanadium composition with about 1.3% Mn and 0.1% V.

More recently, however, welding has been very largely used for the construction of ships, so weldability of the steel has become of primary importance. At about the same time the demand for vanadium in other applications, chiefly tool-steel, became so great on account of war activities that a shortage developed, and titanium was adopted in its place in the high strength plate. On the whole the use of titanium has been eminently successful, but questions arose as to the proper range of titanium and manganese for the best weldability compatible with the strength requirements. Some manufacturers of the steel preferred to add only the minimum amount of titanium, or around 0.01%, and to rely on small contents of nickel, copper, or chromium (mostly residual from the melting scrap) for supplementing the strengthening effect of the manganese without embrittlement. Others added up to about 0.07% titanium, utilizing the marked strengthening effect of that alloy on steel in the as-rolled condition. The weldability of both kinds of manganese-titanium steel has proven to be entirely satisfactory as long as the chemical composition has been held within the limits of the specification. However, with carbon above 0.18% or manganese above about 1.5%, welding difficulties may of course be expected.

At the present time, the supply of vanadium is more adequate, and the question has arisen as to whether the manganese-titanium high strength plate steel should still be used, or whether the vanadium steel is worth the additional expense, or whether some other low alloy, high strength steel might be even better. Furthermore, the matter of preference between the very low titanium grade of manganese-titanium steel and the grade with slightly more titanium has not been definitely settled. The investigation here reported was undertaken to secure, under carefully controlled laboratory conditions, some comparable data on the different kinds of manganese-titanium steel as well as other more or less common types of steel suitable for high strength weldable plates. This should be a start toward finding a conclusive answer to these questions.

Materials Used in the Investigation

The steels discussed here were all made in a small induction furnace, by the same practice, using identical melting stock. With this stock, the following residuals were present in all the steels: 0.035% sulphur, 0.010% phosphorus, 0.12% copper, 0.11% nickel, 0.09% chromium and 0.03% molybdenum.

The heats were all deoxidized with 1 lb. aluminum per ton, which was the last addition to the melt (unless titanium, vanadium, or zirconium was used, in which event the aluminum preceded that other alloy). TAM 40% low carbon ferrotitanium, containing aluminum and low silicon, was used as the source of titanium except in Steel No. 2 with lowest content, to which medium carbon ferro-carbon-titanium was added. This procedure is in line with usual commercial practice where the less expensive, higher carbon ferrotitanium is used only when low residual titanium contents are desired.

The analyses of the ingots are given in Table I. These compositions were designed to meet the Navy specification for high tensile plate ½-in. thick, namely at least 48,000 psi. yield point and not over 87,000 psi. tensile strength in the as-rolled condition. All the experimental steels fulfilled these requirements.

The ingots were heated 4 hr. at 2200° F. to simulate commercial soaking pit practice, and forged to flat bars about 24 by 3 by ½ in. In forging the ingot was first flattened slightly, then reheated at 2200° F., and finally forged to the finished shape without further reheating. All bars were finished at a dull red heat. An efficient sinkhead, which was poured in a hot top on the ingot mold and discarded after forging, prevented any pipe in the finished bars.

Methods of Testing

Several different methods of testing were employed in this investigation:

1. **Tensile tests** were made with specimens machined to ½-in. diameter or smaller, with 2-in. gage length. Specimens were tested *(a)* in the as-forged condition, *(b)* after stress relieving 3 hr. at 1100° F., and *(c)* after welding, respectively. The welded specimens had an ordinary double-V butt-weld at the middle of the gage length, all the welds being made in exactly the same way using an alloy rod to produce a weld stronger than the plate.

2. **Charpy impact tests** were made with specimens 0.39 in. square cut lengthwise near the edges of the forged bars. They were notched with the standard Izod V-notch on a side parallel to the broad surface of the bar. Two tests were made at 32° F. and two at —30° F. on each steel.

Table I — Chemical Analyses of the Steels Used

No.	C	Mn	Si	Cu	Ni	Cr	Mo	Ti	Other
1	0.17	1.56	0.30	0.12	0.11	0.09	0.03	....	
2	0.17	1.31	0.29	0.12	0.11	0.09	0.03	0.011	
3	0.16	1.07	0.25	0.12	0.11	0.09	0.03	0.046	
4	0.165	1.22	0.23	0.12	0.11	0.09	0.03	0.051	
5	0.165	1.10	0.32	0.12	0.11	0.09	0.03	0.074	
6	0.16	0.80	0.23	0.12	0.11	0.09	0.03	....	0.11% V
7	0.14	1.03	0.22	0.12	0.11	0.09	0.03	....	0.11% V
8	0.18	1.29	0.24	0.12	0.11	0.09	0.15	....	
9	0.16	1.05	0.24	0.12	0.11	0.09	0.15	....	
10	0.17	1.21	0.29	0.12	1.43	0.09	0.03	....	
11	0.175	1.29	0.29	0.68	0.11	0.09	0.03	....	
12	0.16	1.29	0.29	0.12	0.11	0.64	0.03	....	
13	0.14	0.70	0.17	1.00	0.50	0.09	0.03	....	
14	0.16	0.79	0.18	1.02	0.53	0.09	0.03	....	
15	0.15	0.72	0.76	0.24	0.20	0.61	0.03	....	0.11% Zr
16	0.15	0.48	0.33	0.40	0.35	0.09	0.18	....	0.035% P
17	0.155	0.53	0.43	0.36	0.36	0.09	0.17	....	0.028% P
18	0.15	0.47	0.32	0.40	0.33	0.09	0.18	0.047	0.032% P
19	0.165	0.55	0.43	0.38	0.37	0.09	0.17	0.064	0.032% P

3. As a measure of the susceptibility to strain aging, **work-brittleness tests** were made on each steel in two conditions, namely, as forged and stress-relieved 3 hr. at 1100° F. The method, which was originally described by Graham and Work (*Proceedings* of the A.S.T.M. for 1939, p. 571) consisted in drawing round tapered specimens through a die at room temperature, then aging 1 hr. at 450° F. and 30 days at room temperature, and finally making Izod impact tests at 45° V-notches 1.1 in. apart along the length of the bar. In this way the effect of different amounts of strain was determined on the notch toughness after aging.

4. **End-quench hardenability tests** were made by the Jominy method, using ½-in. diameter specimens and a ¼-in. water jet. The specimens were heated at 2100° F. before quenching, with adequate precautions to prevent scaling at the quenched end. The hardenability value for each steel was taken as the distance, in sixteenths of

Table II — Average Tensile Results, Not Welded

Class of Steel	Serial Numbers	Yield Point	Tensile Strength	Yield Ratio	Elongation in 2 In.	Reduction of Area
Plain Mn	1	55,000	82,500	66.7	30.7	63.9
Mn-0.011% Ti	2	56,050	77,150	72.7	32.0	66.0
Mn-0.045% Ti	3, 4	52,470	72,620	72.2	30.9	68.7
Mn-0.074% Ti	5	60,750	78,300	77.6	30.5	67.2
Mn-V	6, 7	67,420	83,700	80.5	26.2	65.5
Mn-Mo	8, 9	55,000	78,470	70.2	31.7	63.1
Mn with Ni, Cu, or Cr	10, 11, 12	57,950	83,780	69.2	29.2	63.8
Cu-Ni	13, 14	62,550	79,120	79.0	28.2	64.1
Cr-Si-Zr	15	55,950	78,450	71.4	27.7	67.9
Cu-Ni-Mo	16, 17	57,650	77,370	74.6	28.4	61.8
Cu-Ni-Mo-Ti	18, 19	58,100	75,570	77.0	27.1	63.4

an inch, from the quenched end to the point of inflection of the hardness curve plotted in the usual way on standard cross-section paper. This corresponded to about Rockwell C-28 to 33.

5. Notch-bend weld tests were made on samples on which a single bead had been deposited crosswise under carefully controlled, uniform speed, current, and other conditions. No preheating or subsequent heat treatment was applied. After cooling the bead was machined smooth with the surface of the plate, and specimens were machined ¾ in. wide and ⅜ in. thick so that the weld bead was crosswise at the middle of one side. A 45° V-notch was then cut at the weld, 0.04 in. deep, with apex tangent to the boundary of the fused zone, and the specimen was bent slowly on supports 3 in. apart with the notch in tension. The load and deflection were recorded when failure was indicated by a decrease in resistance to load and the beginning of a crack in the notch. These tests were all made at least six weeks after welding, to insure complete relaxation of all the welds.

6. Notch-impact weld tests were also made with Charpy test specimens cut, machined, and notched like the bend test specimens, except they were about 0.393 in. square. The same weld bead was used for both types of specimens, and the impact tests likewise were made at room temperature at least six weeks after welding.

7. Weld hardening tes were made on smooth se tions cut perpendicular the weld beads, the sides the impact specimens bei used for this purpose befo they were completel machined. Rockwell A har ness was determined at fou points just below the fus zone where weld-hardeni was greatest, and compare with similar readings tak the same distance below t surface of the plate at point remote from the he affected zone. The differen is reported as the maximum hardness increa due to welding. All these weld tests were ma in duplicate, using two specimens, but both we cut through the same weld bead deposit.

Table III — Average Notched-Bar Impact Resistance, Ft-Lb. (Not Wel

Class of Steel	Serial No.	As Forged, Not Pre-Strained		Tested At 70° F. After Aging			
				As Forged		Stress Relieve	
		At 32° F.	At −30° F.	Strained 1 to 2%	Strained 7 to 8%	Strained 1 to 2%	Strai 7 to 8
Plain Mn	1	22.0	13.3	29	9	68	51
Mn-0.011% Ti	2	66.8	23.4	60	19	84	56
Mn-0.045% Ti	3, 4	66.9	17.7	69	33	59	26
Mn-0.074% Ti	5	25.3	20.1	56	24	95	14
Mn-V	6, 7	71.8	25.7	57	26	51	16
Mn-Mo	8, 9	58.1	24.3	50	16	59	47
Mn with Ni, Cu, or Cr	10-12	27.4	17.0	61	18	74	45
Cu-Ni	13, 14	75.9	23.4	62	23	68	38
Cr-Si-Zr	15	63.4	21.9	74	40	66	21
Cu-Ni-Mo	16, 17	30.9	16.9	57	15	66	41
Cu-Ni-Mo-Ti	18, 19	24.6	21.9	55	18	47	25

Results of Tensile and Impact Tests

Neither stress relieving nor welding w found to change materially the tensile properti of the steels except that — since the welds we stronger than the other parts of the welde specimens — the elongation of those specime was considerably reduced. None of the welde specimens broke in the weld, and none of th welds showed any cracks in the base met although all were examined both microscopicall and by deep etching at both ends. These we tensile tests proved without question that an strength derived by these steels in the as-forge condition from the titanium or vanadium conte

was not lost in welding, in spite of the heating effect of the arc.

To simplify the comparison of the different grades of steel included in this investigation, only average properties for each grade are reported. The individual test results are available in the author's laboratory, and will gladly be submitted to anyone interested in the details. Thus in Table II, the properties as-forged and in the stress relieved condition, which differed very little, are combined for each class of steel noted.

Table II shows that the manganese-vanadium steels were highest in yield point and yield ratio, but rather low in ductility, especially elongation. The copper-nickel steels were somewhat similar to the manganese-vanadium in both these respects. The titanium steels compared favorably with the others in yield ratio and, together with the zirconium steel No. 15, had the highest reductions of area. Thus the manganese-titanium steels were not inferior to any of the other steels in either yield ratio or ductility. This holds true for steel No. 2 with even as little as 0.011% titanium, although the plain manganese steel No. 1 had the lowest yield ratio and only moderate reduction of area. In all tensile properties except elongation, the steel containing 0.074% titanium surpassed those with less titanium. (It should be remembered that none of these specimens were normalized.) The effect of titanium in improving the yield ratio and reduction of area is illustrated by the last two lines of Table II as well as the first four.

Notched-bar impact tests, both at low temperatures and after strain aging, but exclusive of the welded specimens, are given in Table III. Some of the work-brittleness curves from which the data in the 5th and 6th columns of this table were derived are reproduced in Fig. 1. Comparisons can probably be made more clearly from the average values in Table III than if all the individual curves were given.

From the data in Table III it is evident that the manganese-titanium steels are not particularly tough when notched and subjected to impact at 30° below zero, although in the as-forged condition at room temperature the steels with 0.04 to 0.05% titanium are tougher and more resistant to strain-aging embrittlement than any of the others except the zirconium-treated steel No. 15. The manganese-vanadium steels do not resist strain-aging embrittlement so well, but are the toughest at low temperature. The manganese-molybdenum and copper-nickel steels are also quite tough at the lower temperatures, but the copper-nickel-molybdenum steels No. 16, 17, 18 and 19 are not, probably on account of their higher phosphorus and silicon contents. The plain manganese steel No. 1, and the other manganese steels with molybdenum, nickel, copper, or chromium, No. 8 to 12 inclusive, are all much tougher when strained and aged after stress-relieving than in the as-forged condition, whereas stress-relieving made the zirconium-treated steel No. 15, the manganese-vanadium steels, and most of the manganese-titanium steels less tough. Thus there seems to be an indication of some precipitation effect at 1100° F. in the latter three

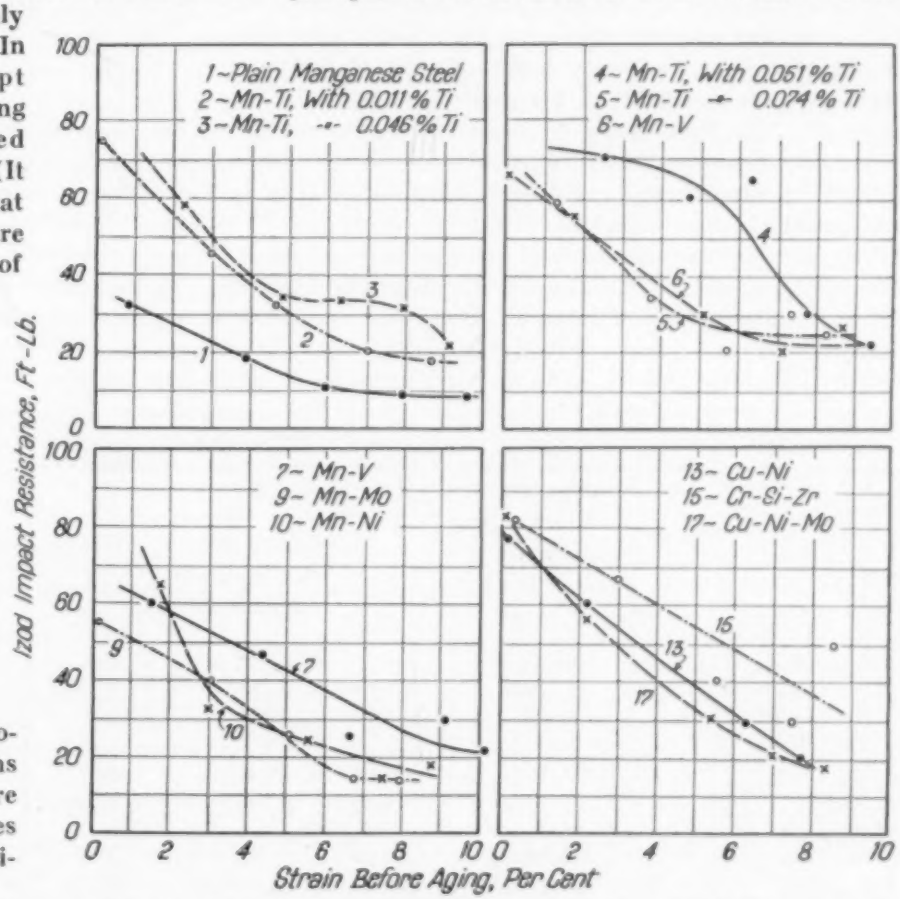
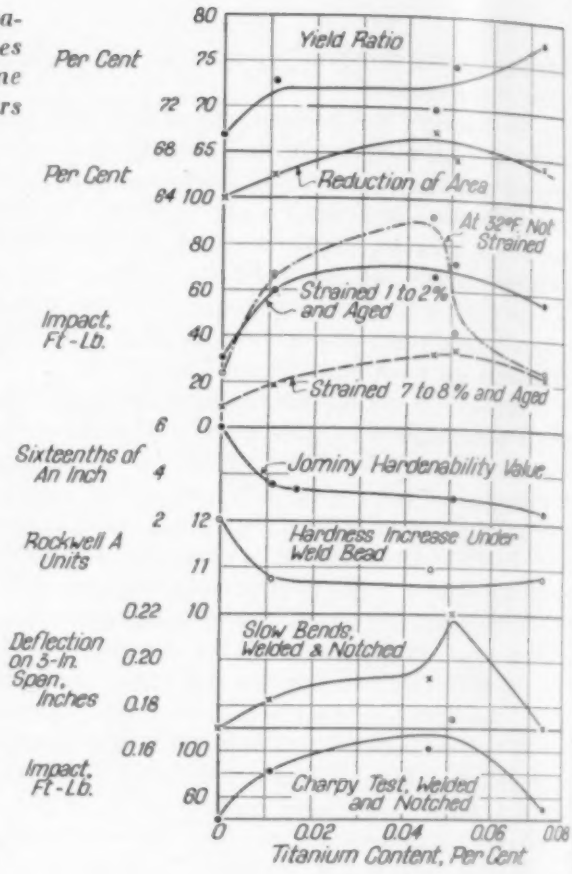


Fig. 1 — Results of the Work-Brittleness Tests on Representative As-Forged Specimens, Indicating the Susceptibility of All the Steels to Lose Notch-Bar Toughness After Strain and Aging

Fig. 2 — Variation of Some Properties of Manganese-Titanium Steels as the Titanium Increases to 0.074%, All Steels Having About the Same Tensile Strength As-Forged to ½-In. Bars



kinds of steel after the high temperature treatment of the ingots at 2200° F. The low-titanium steel No. 2 however was improved by stress relieving, like the plain manganese steel No. 1; but it differs from No. 1 in being much tougher in the as-forged condition and when tested at low temperature.

In Fig. 1 it can be seen how the work-brittleness curves for the medium-titanium steels No. 3 and 4, and the zirconium steel No. 15, in the as-forged condition, stand out higher than the other steels, indicating less susceptibility to strain aging embrittlement.

Hardenability and Single-Bead Weld Tests

The results of the end-quench hardenability tests, and of the tests of specimens cut from the single-bead weld deposits are summarized in Table IV to facilitate comparison of the various steels.

Although there are some marked discrepancies between the data in the third and fourth columns of Table IV, the titanium steels are generally among the less hardenable steels by both methods of testing, and certainly much better than the plain manganese steel No. 1, or the manganese-nickel, manganese-copper or manganese-chromium steels No. 10, 11, and 12. The manganese-vanadium steels, and the low manganese-copper-nickel-molybdenum steels No. 16 to 19 hardened somewhat less below the weld bead than the manganese-titanium steels. It is quite clear from the other data in Table IV, however, that weld hardening is not always directly related to weld ductility or weld toughness. The zirconium-treated steel No. 15, for instance, hardened considerably yet had good ductility in bending, and the opposite is true of the copper-nickel steels No. 13 and 14. The manganese-titanium steels with 0.04 to 0.05% titanium were more ductile and tough under the weld bead than any of the others, even though the manganese-vanadium steels showed less weld hardening. The favorable effect of titanium on weldability is also well illustrated by the last two lines of Table IV. But with as much as 0.074% titanium, as in steel No. 5, the weld toughness was comparatively poor.

Table IV — Averages of Hardenability and Single-Bead Weld Tests

Class of Steel	Serial No.	Hardenability Distance to Inflection of Hardenability Curve	Single Bead Welds		
			Max. Weld Hardening	Notch-Bend Deflection 3-In. Span	Notched Impact Resistance Ft-Lb.
Plain Mn	1	6.0/16ths.	A-12.0	0.170 in.	40.0
Mn-0.011% Ti	2	3.5/16ths.	A-10.7	0.183 in.	81.3
Mn-0.045% Ti	3, 4	3.0/16ths.	A-10.6	0.206 in.	114.9
Mn-0.074% Ti	5	2.5/16ths.	A-10.8	0.170 in.	49.5
Mn-V	6, 7	3.2/16ths.	A-7.4	0.191 in.	109.7
Mn-Mo	8, 9	3.3/16ths.	A-11.7	0.168 in.	71.3
Mn with Ni, Cu or Cr	10-12	5.7/16ths.	A-14.8	0.154 in.	51.3
Cu-Ni	13, 14	3.5/16ths.	A-10.5	0.143 in.	95.3
Cr-Si-Zr	15	3.5/16ths.	A-13.0	0.192 in.	65.9
Cu-Ni-Mo	16, 17	3.0/16ths.	A-8.9	0.202 in.	69.5
Cu-Ni-Mo-Ti	18, 19	2.5/16ths.	A-9.1	0.249 in.	73.9

Discussion

As a concise summary of the more important results of this investigation Table V is presented, but it should be read only with a clear understanding that the terms used are purely relative among these particular laboratory-melted

steels only, and that the differences between them are in many instances very small. The variety of steels tested, and of the testing methods, seems to prohibit the preparation of a less complicated summary, or the neglect of the five explanatory notes if a fair appraisal of all the steels is to be attained.

From Table V it is evident that the moderate titanium steels have the best general rating, being inferior only in low temperature notch toughness. The vanadium steels are slightly deficient in ductility, deeper hardening, and more susceptible to strain-aging embrittlement, though tougher at low temperature. The lower titanium steel seems to be in general about equal to the vanadium steel, and of course is decidedly less expensive. The zirconium-treated chromium-silicon steel is also very similar, though somewhat lacking in weld notch toughness. Among the other steels the copper-nickel type seems to be next best, though lower in ductility. The copper-nickel-molybdenum steels, similar to the recommendation of Brooks and Waggoner for superior weldability, in a recent Welding Society paper, were rather disappointing in notch toughness and tensile ductility, though with titanium added their weld ductility was excellent and their weld hardening and hardenability were low. Possibly this steel would have been more satisfactory with lower phosphorus and silicon. The higher titanium manganese-titanium steel was only slightly better than the plain manganese, except in resistance to strain aging embrittlement and low hardenability.

In general, therefore, titanium in favorable amounts is thus shown to be at least as suitable as the more expensive vanadium (and much better than small additions of nickel, copper, chromium or molybdenum) for improving the useful properties of the popular and economical pearlitic manganese plate steel. To bring out more clearly the evidence derived from this work as to the best amount of titanium in the manganese-titanium steel for maximum yield ratio, ductility, toughness, and weldability, the values found for these properties are plotted against the titanium content in Fig. 2. Only the curves for yield ratio and end-quench hardenability show a uniform direction of slope as the titanium rises. The curves for reduction of area in tension, notched-bar impact resistance, and notched weld-bend deflection all indicate a maximum somewhere between 0.011 and 0.051% titanium, or most probably around 0.04%. Thus, titanium contents as high as 0.07% should be avoided, as well as lower contents than 0.01%, for the best welding quality in this manganese-titanium plate steel in the as-rolled condition. The reason for this is no doubt connected with the solid solubility of titanium carbide at soaking pit temperatures, and normalizing might very likely change the situation completely.

The results here reported were obtained with laboratory melted steel, and any conclusions drawn from them should be considered as tentative for that reason. They have an advantage over tests made on commercial steels, however, in that identical melting stock was used, so the effect of residual alloys from scrap was constant. Confirming tests on commercial ½-in. plates from several sources are under way at present, and will be reported when completed.

Table V — Summary of Results

Kind of Steel	Tensile Ductility	Notch Toughness at 32° F.	Resistance to Strain-Aging Embrittlement As Forged	Hardenability by End-Quench Test	Notched Weld Ductility	Weld Notch Toughness
Plain Manganese *(a)*	Poor	Poor	Bad	High	Poor	Bad
Mn-Ti, Low Ti	Fair	Fair	Fair	Moderate	Fair	Fair
Mn-Ti, moderate Ti	Good	Fair	Good	Low	Good	Good
Mn-Ti, higher Ti	Fair	Poor	Fair	Low	Poor	Poor
Mn-V	Poor *(b)*	Good	Fair	Moderate	Fair	Good
Mn with other Alloys	Poor	Poor	Poor	High *(d)*	Poor	Poor
Low Mn, with Ni, etc.	Poor	Good *(c)*	Fair	Low	Good *(e)*	Poor *(e)*
Cr-Si-Zr	Fair	Fair	Good	Moderate	Fair	Poor

Notes:

(a) This steel contained higher manganese than the others in order to meet the strength requirements without other alloy additions.

(b) The vanadium steels had the highest yield strength.

(c) Steels No. 16 to 19, with higher phosphorus and silicon, had low notch toughness.

(d) The Mn-Mo steels had moderate hardenability.

(e) The Cu-Ni steels had low weld ductility, but fair weld toughness.

Preferred Orientation —an Asset and a Liability

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A rolled or forged metal may have "fiber" due to segregation of metallographic constituents, but the author comments on the fact that directional properties ("anisotropy", to the scientist) due to preferred orientation of the basic metallic crystals are seldom of advantage except in the production of magnetic silicon-iron sheet.

ONE USUALLY THINKS of a cast or wrought metal as being isotropic in its physical properties, equal in all directions, a condition which implies that the grains of the metal are randomly situated and oriented with respect to each other. Yet isotropy is not necessarily a property of commercial metals; under certain conditions they can be actually anisotropic in their properties, showing considerable variation with direction of testing, in which case the implication is that the component crystals are lined up in a more-or-less definite geometrical manner giving rise to a phenomenon called "preferred orientation". One of the reasons for the observer being unaware of anisotropy is in part due to his reliance on the microscope which does not reveal the internal crystallographic arrangement of the crystals except where etch pits are developed or when one can make a statistical evaluation of the directions of twins in twinned materials like brasses. Ordinarily it is necessary to resort to X-rays, mechanical and magnetic tests to show the existence of preferred orientation.

Anisotropy which is due to preferred orientation of the crystals gives rise to directionality in metals and alloys and this denotes, or connotes, an appreciable variation in physical characteristics (usually in sheets, or sometimes wires) with respect to a reference direction, such as the rolling direction in sheets, and the fiber axis in wires. Variations occur in such properties as yield strength, tensile strength, elongation, moduli of elasticity, and magnetic quality, namely permeability and losses, depending on the direction of testing.

In the electrical industry, one of the most significant improvements since Robert Hadfield's introduction of silicon-iron at the turn of the century has been the use of highly oriented silicon-irons in distribution, power and miscellaneous transformers. The main advantages of such materials are that the transformers can achieve higher flux densities at lower magnetizing forces. The designer is then able to take such improved materials and build smaller and lighter transformers for the same rating.

On the other hand the deep drawing industries have come to appreciate the harmful effect that directional properties have in, say, low carbon steels or copper base alloys. The severity of modern drawing practice makes random orientation a much desired property, for preferred orientation means differential ductility. Directionality in deep drawing metals, caused primarily by preferred orientation but also by chemical segregation, abnormal grain size structure and non-metallic inclusions, is often responsible for uneven metal flow and for actual metal failure.

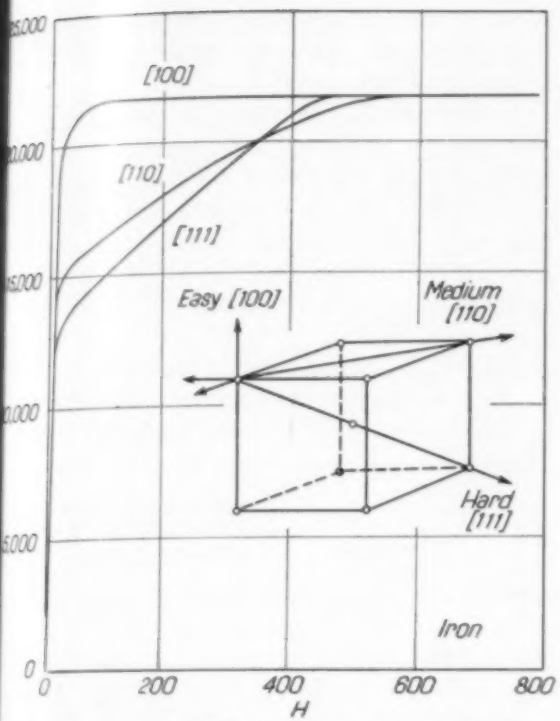


Fig. 1 — Crystal Structure of Iron and the Types of Magnetization Curves Obtained in Principal Crystallographic Directions

Perhaps before entering into a discussion of the advantages of preferred orientation in electrical sheets and the disadvantages of preferred orientation in deep drawing sheets, it might be well to dwell a little more on the orientation phenomenon.

Fiber Texture

When a metal is appreciably cold worked the crystal orientation is changed so that certain crystallographic axes are aligned with respect to the principal flow directions in the metal, thus giving rise to a preferred orientation of the crystals. The type of deformation texture (in wires usually called a "fiber texture") depends on the metal and the nature of flow during deformation.

Orientations developed on cold working are not usually obliterated by annealing; rather, they are changed into new orientations called "recrystallization textures". Soft magnetic alloys with pronounced directionality are of this recrystallization texture. Strains produced by cold work have an extremely adverse effect on magnetic permeability and magnetic losses, and consequently soft magnetic alloys must be annealed after being rolled to reduce internal strain to a low value.

No strict rules can be set forth for obtaining preferred and random orientations because each metal and alloy is a special case in itself. There is an interdependence of reductions and annealing temperatures; in some metals, mostly in non-ferrous alloys, the composition also plays an important role.

Preferred orientation can generally be obtained by various metallurgical processes involving cold rolling, usually above 50% reduction, and high annealing temperatures for intermediate and final anneals. In iron, iron-silicon, and iron-aluminum sheets the cold rolling orientation increases with increasing reductions, but the best recrystallization orientation is developed in material previously cold worked about 60%. (This behavior on recrystallization apparently does not hold for non-ferrous alloys. Copper strip, for example, which has been cold worked 99% gives a recrystallization texture that is almost perfect in cubical alignment.)

Random or only slight orientation can be obtained by a procedure opposite to that used for getting preferred orientation — that is, small reductions (less than 50%) and low intermediate and final anneals. In materials like iron and low carbon steel, which possess a crystallographic transformation, the cold working and recrystallization orientations can be removed by cooling through the transformation temperature.

The development of highly oriented silicon-irons is an excellent illustration of theoretical knowledge leading to very useful commercial application. The idea of magnetic anisotropy dates back to 1918 when Karl Beck, a student of Weiss* at Zurich, showed that single crystals of iron had directions of easy and of difficult magnetization. Two of Beck's seven crystals were from an old grate bar, and five from a thermit fusion which gave him 98% iron with silicon as the principal impurity. Using purer iron crystals, workers like Honda and Kaya, around 1926 and later, verified Beck's results. See Fig. 1 which shows the $B - H$ vs. H curves for the various crystallographic directions.

For some years after that little was done about this magnetic anisotropy, though experimenters appreciated the benefits that would accrue if a polycrystalline magnetic sheet could be made with a preferred orientation so that the cube edge of the crystals in the sheet would line up with the rolling direction. Workers were eventually successful in producing silicon-iron with unusually high permeabilities in the rolling direction by a combination of cold rolling and annealing. Diligent research in the field, coupled

*P. Weiss was one of the first workers in magnetism who described ferromagnetism quantitatively with some degree of success.

with the extensive work at the Westinghouse Research Laboratories on the effect of impurities, has led to further improvements in magnetic permeabilities and losses in silicon-iron.

Figure 2 illustrates the improvements that have been made in magnetic permeability. The old type, high grade transformer 4% silicon-iron is shown in comparison with a highly purified and oriented silicon-iron known as "Hipersil" (a Westinghouse trademark for High Permeability Silicon-Iron), a single crystal of 3.9% silicon-iron measured by Williams in 1937, and the dotted line theoretical limit. The polycrystalline oriented silicon-iron, Hipersil, is obviously a great improvement over the old style hot rolled silicon-iron, its characteristics approaching those of a single crystal. These are radical advances from the properties shown in Beck's classical paper.

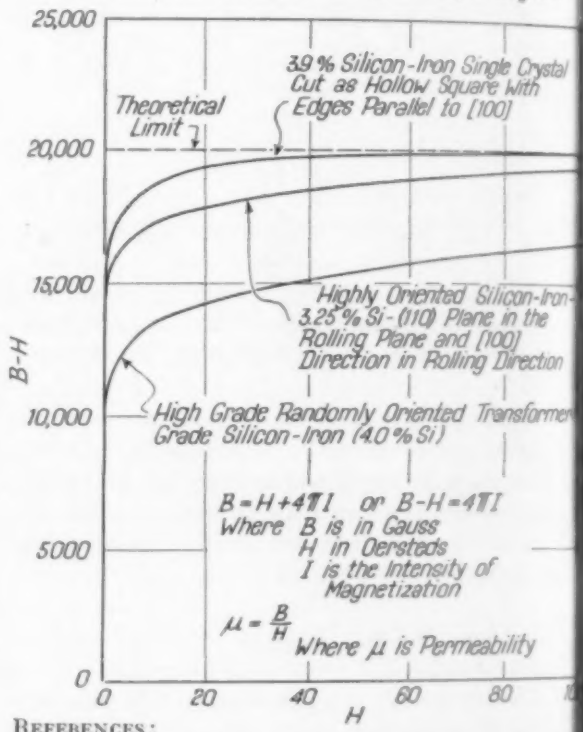
Mechanical Uses of Anisotropy

Preferred orientations are also sometimes beneficial from the mechanical standpoint. For example, in wires it gives significant increases in the yield and ultimate strength over randomly oriented wire of the same grain size. Again, the hexagonal metals like zinc and magnesium show marked preferred orientation due primarily to the limited manner of (basal) slip. In magnesium and its alloys, forming operations are often carried out to obtain the benefits of preferred orientation in a wide range of tensile and elongation values. Magnesium forgings tend to have more of the crystallographic fibering than the mechanical fibering common to ordinary steel forgings, and this preferred orientation is regarded by forge men as a desirable property in this class of material.

While thus in magnetics the high permeabilities obtainable due to the recrystallization texture have proved to be an asset to the electrical industry, and while some mechanical benefits have been derived from the same phenomenon, preferred orientation is recognized to be decidedly harmful in a piece of sheet or strip which is deep drawn or cupped. Users of such ferrous or non-ferrous products abhor directionality; their specifications call for sheets having randomly oriented structures. Indeed, preferred orientation must be considered a defect by them, because it may be the actual cause of breakage and, if not, it gives rise to what is sometimes objectionable — uneven metal flow. J. E. Stead away back in 1898 pointed out that annealed mild steel sheets sometimes gave "rectangular" brittleness — that is, the sheets were satisfactory as to mechanical properties in the rolling direction but were unsatisfactory 45° to the rolling direction. He correctly interpreted the phenomenon as an internal lining-up of the grains.

Directionality in sheets is caused by numerous factors, preferred orientation of the grains being only one but a most important factor. Some other causes of directionality are: Segregation due to piping, common in steel but less so in non-ferrous metals; segregation of major constituents like pearlite stringers; segregation of

Fig. 2 — Comparison of Magnetic Properties (Random and Preferred Orientation) of Silicon-Iron With Those of a Single Crystal



REFERENCES:

For single crystal see H. J. Williams, *Physical Review*, 1937, Vol. 51, page 1009; for silicon-iron see F. Bitter, "Introduction to Ferromagnetism" (McGraw-Hill Book Co., 1937) pages 89 and 115.

impurities like phosphorus giving ferrite "ghosts"; impurities and inclusions, sometimes difficult to identify, giving rise to regions of fine grains within a coarser matrix. However, such factors are outside the scope of this paper. The type of directionality discussed here is that of crystal orientation — the lining up of the crystals in a preferred crystallographic direction — obtained during cold rolling and often persisting after annealing. The recrystallization orientation is the texture with which one is concerned in deep drawing, as most such sheets are in a well annealed condition.

In modern practice where the metal is

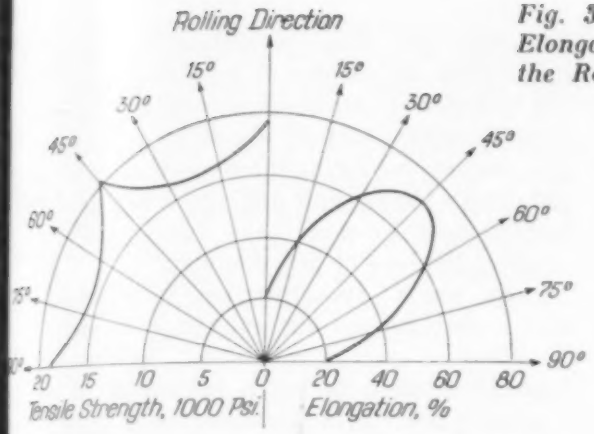
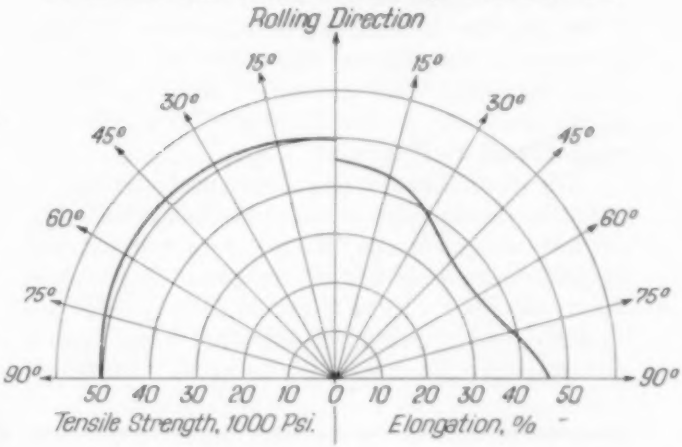


Fig. 3 — Variation in Strength and Elongation in Copper With Respect to the Rolling Direction (After Sachs)

Fig. 4 (below) — Variation of Strength and Elongation in Low Carbon Steel With Respect to the Rolling Direction (Phillips and Dunkle)



worked nearly to its breaking point, the amount of preferred orientation in the sheet may constitute the difference between a successful and unsuccessful draw. Cases have been known where deep drawing steel has been drawn to size in such a manner that it is cold worked and stressed to its limit and fails, even though it be free of other defects, merely because of slight orientation causing a split in the region where ductility is at a minimum.

While it is true that drawing difficulties due to grain orientation are rare, it is none the less important to recognize this factor when it appears so that valuable time is not wasted, because little if anything can be done about it by the draw shop. The requirement of random orientation in sheets is chiefly the manufacturer's rather than the fabricator's responsibility.

Some idea of the variations in tensile strength and elongation in low carbon steel and copper that can be caused by preferred orientation of crystals due to the recrystallization texture is given in Fig. 3 and 4. Variations of greater or less extent can be developed by different treatments, so that these figures indicate circumstances for only one particular type of treatment. Considerably more literature is available on orientation in copper and copper base alloys than in low carbon steel. The data in Fig. 3 for copper were apparently obtained from a highly oriented sheet, while it is not known whether the degree of orientation in connection with the data of Fig. 4 for iron is high or low, or whether the anisotropy of low carbon steel does or does not cause such large variations in tensile strength and elongation as it does in copper.

In the drawing of cups or similar articles from a round blank, the preferred orientation will show up as ears symmetrically located with respect to the rolling direction. Figure 5 shows ears in a copper base alloy. These ears can occur at 45° (or at 0° and 90°) with respect to the rolling direction, and quite often both types of earing can occur in the same material made by different treatments. In the drawing of non-symmetrical shapes uneven flow can result if sufficient orientation is present, even though no rupture occurs. In such irregular shapes, or even

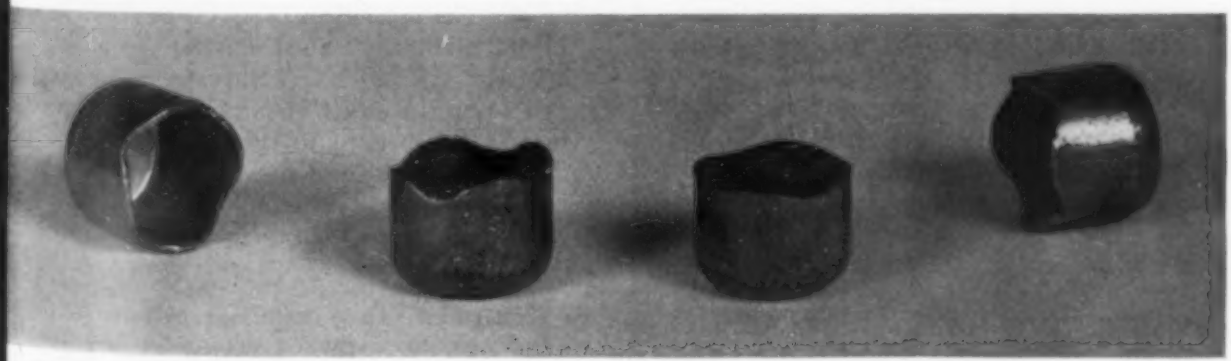


Fig. 5 — Earing in a Copper Base Alloy Having Directionality Due to Preferred Orientation. (Photo courtesy American Brass Co.)

in rectangular ones, it is virtually impossible to strain all regions of the blank uniformly; it is then that the disadvantages of orientation show up, because wrinkling, puckering, earing, thinning, or even actual breakage will occur in regions of maximum deformation.

The resultant non-uniform flow of a blank in the die due to orientation implies a thinning of the sheet in regions and directions of maximum ductility. This associated thinning of the article may be a disadvantage if a strength requirement must be met.

Directional properties due to preferred orientation in sheets can sometimes be tolerated without any serious harm. If earing on symmetrical shapes, or uneven flow on irregular shapes does occur, the edges can be trimmed as they often are without much trouble. On the other hand, should directionality be unusually severe, insufficient flow may take place in certain regions so that the desired dimensions of the drawn article cannot be attained. Since economy is the watchword of any business, blanks are made of the smallest size possible to attain the desired dimensions of the drawn object, and difficulties can arise from uneven flow so that these dimensions are not attained because of low ductility.

By way of recapitulation, it is indeed rare that a phenomenon like anisotropy in metals can be either an asset or a liability. At one extreme high *orientation* is taken advantage of in the magnetic field to produce improved transformer alloys, and at the other extreme, *random* orientation is highly desirable in the deep drawing art. The importance of anisotropy has been recognized only within recent years, and means for controlling orientation have been discovered to the great benefit of the metals industry.

National Emergency Steels for Heavy Naval Forgings

FOR MANY YEARS the Navy has been investigating the properties of steels which are employed in the machinery of naval vessels. Due to the service conditions involved, primary interest has been centered in such properties as notch toughness and fatigue resistance, particularly in alternating torsion. Special emphasis has been placed on the variation of properties in forgings of such size that normalizing and tempering is the only practical method of heat treatment.

It is therefore natural that these studies be extended to the new steel analyses developed to conserve critical alloying elements, especially since no information was available for other than quenched and tempered parts for small machinery. Large forgings are required for propulsion shafting and rudder stocks which must conform to the physical properties of Classes An and HG alloy steels of Navy Department Specification 49S2 (INT). Ordinarily, the Navy Department purchases steels in accordance with physical properties rather than chemical requirements. Chemical and physical requirements taken from this specification (issue of Aug. 15, 1944) are listed on top right column on the next page.

In all, 36 steels representing the following 10 grades are being investigated: *8339*, *8442* 8630, *8739*, *8744*, *8749*, *8949*, *8949* modified, *9442* 9450. [Italic numbers represent grades dropped from the May 26, 1944 list; where the compositions fall within existing specifications, as 8740 8745 and 8750, the steels have been so regarded by the Editor]. The sizes range from 1 in. to 14 in. diameter. Similar steels obtained from different sources are being tested in order to determine the effect of manufacturing variables. In view of interest in these steels in large sections, and because of the inherent hardenability, normalizing and tempering heat treatments were given preference over quenching and tempering procedures. The forgings were normalized in fu

*Extracts made with approval of Bureau of Ships from copyrighted article in the *Journal* of the American Society of Naval Engineers for August 1944, entitled "Chemical and Mechanical Properties of Some of the National Emergency Steels".

section and tempered in as large sections as practicable, except in those few cases in which the manufacturer performed the entire heat treatment on the forging.

Tests include the determination of static tensile and torsional properties, Charpy impact value, hardness, and fatigue resistance in rotating flexure and alternating torsion. The hardenability was determined by means of the end-quench test. Temperature-expansion (dilatometric) curves were obtained for representative steels. In determining these properties the location of specimens with reference to the cross section of the forgings was considered. In addition, the high temperature characteristics of some of the steels were determined. Tension tests were made of standard 0.505-in. threaded-end specimens. Static torsion tests were made of 0.75-in. diameter specimens. Charpy impact values were obtained from 10-mm. square keyhole notch specimens.

Extracts From Specification 49S2 (INT)

"Steel Forgings for Hulls, Engines, and Ordnance"

	Class An	Class HG
Chemical composition		
Carbon (max.)	0.45%	0.45%
Sulphur (max.)	0.05%	0.05%
Phosphorus (max.)	0.05%	0.05%
Others	Note *(a)*	—
Physical properties		
Tensile strength (min.)	80,000 psi.	95,000 psi.
Proof stress (min.)	45,000 psi.	65,000 psi.
Elongation in 2 in.		
Longitudinal (min.)	25%	21%
Transverse (min.)	21%	18%
Reduction of area		
Longitudinal (min.)	45%	45%
Transverse (min.)	30%	30%

Cold bend (longitudinal test piece, both classes): 180° to inner diameter of 1 in. without cracking.

Note *(a)*: Alloy steels for propulsion shafting, rudder stocks, and pinion gears shall contain 2.75% (min.) nickel, or in the case of propulsion shafting and rudder stocks, may be of the following composition, provided that after heat treatment the required physical properties are met: 0.50 to 0.80% Mn, 0.15 to 0.45% Si, 0.30 to 0.60% Mo, 0.10 to 0.25% V. (Paragraph H-3 of the specification says that the steel should conform to the chemical requirements of the American Iron & Steel Institute's list for alloy steels. "In this selection, advantage should be taken of the possibilities of obtaining adequate physical properties with a minimum of alloy content, such as those offered by the National Emergency steels, although it is not intended to limit such selection to the National Emergency steels.")

By **William C. Stewart**
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and **Richard E. Wiley**
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The fatigue tests in flexure were made with the rotating cantilever type of specimen. In this specimen the test length is conically tapered and so designed that the maximum stress is ¾ in. out from the inner fillet, and the stress varies only about 1.5% over a length of 1.5 in. All specimens were finished by a method of alternate longitudinal and transverse polishing; the surface is sufficiently smooth to permit examination of the structure at 100 diameters. The test length of the specimens was kept covered with a film of mineral oil throughout the test. The endurance machines were operated continuously at 1450 rotations per minute.

Endurance tests in alternating torsion were also made for some of the steels in a machine shown in Fig. 1. One of the shafts is given an oscillating motion by a variable eccentric and opposing spring. This motion is transmitted through the test specimen and is opposed by a standard specimen of high elastic limit which acts as a torsional spring. The stationary end of the standard specimen is mounted in a grip which can be rotated and secured in any desired position. By this means, the standard and test specimens can be subjected to a pre-twist with the oscillating shaft on dead center, and the stress range can be varied. The stress is computed from the magnitude of twist in the standard specimen. For the tests herein reported, the stress was maintained equal positive and negative from the neutral position. All tests were made at 1475

Summary of exhaustive tests made on 12 steels of five NE grades, furnished in the form of 8-in. rounds, which indicate that NE 8630, 8740, 8745 and 9445 will meet requirements of the Navy's Class An for propulsion shafting and pinion gears, when normalized and properly tempered. NE 8745 can meet the more difficult requirements of Class HG.

Longitudinal and Transverse Properties of 8-In. Rounds, Normalized and Drawn

Steel Type	Heats Tested	Heat Treatment		Tensile Properties (a)					Charpy Impact	Brinell Hardness	Torsional Properties			Endurance Limits	
		Normalize	Draw	Ultimate	Proof	0.1% Yield	Elongation (2 In.)	R.A.			Ultimate	Proportional Limit	Modulus × 10^8	Rotating Cantilever	Alternating Torsion
8630	2	1610°, 8 hr.	1200°, 4 hr.	87,400	53,000	53,400	31.8	59.9	32.0	180	67,200	28,000	12.0	38,000	25,000
	1			*84,250*	*51,200*	*51,500*	*30.5*	*48.1*	*18.4*						
	1		1300°, 4 hr.	83,200	52,150	52,600	32.6	62.7	32.2	172	67,300	22,000	12.0	36,000	23,000
8740 (b)	1	1625°, 8 hr.	1000°, 4 hr.	95,750	58,650	59,050	26.7	53.8	28.8	192	74,600	20,000	11.9	38,000	25,000
	3		1200°, 4½ hr.	88,100	53,750	54,250	30.5	59.1	30.5	184	70,600 (c)	25,000 (d)	11.9	37,000	25,300
	1			*89,500*	*57,250*	*57,750*	*28.5*	*53.8*							
	2		1300°, 4½ hr.	85,400	53,150	53,700	31.0	61.4	32.2	175	66,700	24,200	12.0	33,500	24,500
	1			*91,500*	*56,750*	*57,200*	*25.7*	*43.9*							
	1		1500°, 4 hr.	88,350	51,750	52,450	28.7	49.1	25.7	178	65,300	21,000	11.9	38,000	23,000
8740 (e)	1	1625°, 8 hr.	1000°, 4 hr.	121,000	77,850	81,250	20.7	42.0	14.8	273	86,300	19,000	11.7	55,000	37,000
			1200°, 4 hr.	105,900	70,750	71,300	25.7	54.6	22.2	226	75,600	19,000	12.0	49,000	33,000
			1300°, 4 hr.	95,500	60,650	61,950	28.4	60.8	27.7	200	72,300	19,000	11.8	42,000	29,000
			1500°, 4 hr.	114,450	55,000	56,400	23.7	41.7	16.9	227	80,600	17,700	12.1	46,000	
8745 (f)	1 (VF)	1600°, 8 hr.	1000°, 3 hr.	118,400	69,750	75,900	21.2	46.1	17.3	212	83,100	30,000	12.2	46,000	33,000
	1 (VF)		1100°, 3 hr.	119,700	69,900	73,500	21.6	44.3	18.3	217	81,800	32,000	12.0	47,000	32,000
	3		1200°, 4 hr.	102,300	66,850	67,800	26.7	57.2	26.9	215	75,200	38,100	12.0	46,000	30,800
	3			*101,500*	*68,200*	*68,700*	*22.6*	*37.4*	*15.2*						
	4		1300°, 4 hr.	100,200	65,500	66,300	27.8	57.7	25.7 (g)	210	75,800	34,100	12.0	44,000	30,500
	3			*102,000*	*65,600*	*66,600*	*20.6*	*36.7*	*17.5*						
	1 (VF)		1500°, 3 hr.	101,750	55,750	56,900	26.0	46.3	18.0	176	72,400	28,000	12.1	41,000	27,000
9445	1	1650°, 8 hr.	1200°, 4 hr.	106,350	60,800	61,400	25.2	53.7	24.0	210	73,600	28,000	12.1	45,000	31,000
				118,250	*73,550*	*75,750*	*19.0*	*37.7*	*14.8*						
			1300°, 4 hr.	99,750	57,850	59,300	28.2	56.3	24.3	207	71,100	26,400	12.0	43,000	
				99,250	*58,250*	*58,550*	*22.7*	*36.6*	*14.9*						
9450	1	1650°, 8 hr.	1200°, 4 hr.	119,900	57,200	60,550	19.3	42.4	16.9	239	85,100	26,500	12.0	48,000	
				119,250	*55,850*	*58,250*	*14.2*	*17.3*							
			1300°, 4 hr.	109,800	51,950	55,200	22.9	43.8	15.6	222	79,100	26,800	12.0	46,500	34,000
				107,750	*52,700*	*53,700*	*(h)*	*(i)*							

Notes: *(a)* Transverse tests in italic.

(b) Three heats of medium hardenability (Grossmann's critical diameter 3.76 to 3.86 in.)

(c) Range, 65,100 to 80,000 psi.

(d) Range, 19,000 to 30,000 psi.

(e) Hardenability (Grossmann's critical diameter) 4.63 in.

(f) Four heats tested, delivered as 8744, 8749 or 8949 with Grossmann hardenabilities as follows: Heat WY, 4.30 in.; XS, 4.42 in.; VF, 4.65 in.; XE, 4.74 in.

(g) Range: 13.0 to 30.7 ft-lb.

(h) 5.5 to 17.5%.

(i) 5.4 to 20.2%.

stress reversals per min. Details of the alternating torsion endurance specimen are shown in Fig. 2, page 1262.

Results of the tests on large rounds are summarized in the large table at the left. Only those steels which fall within the specification limits of the list current at this date are included.

Editor's Note on Table

NE8740—Four heats falling within specification NE8740 were tested as 8-in. rounds. Three heats were delivered as NE8739 and are of approximately the same hardenability. One (WI) was delivered as 8749 but the carbon content is below specification; its manganese is on the high side, and as shown by the table has considerably higher hardenability. Its physical tests were out of line with the three others and are reported separately in the large table. Chemical compositions are:

	8740 Specification	WE	XF	WG	WI
C	0.38 to 0.43	0.39	0.39	0.40	0.40
Mn	0.75 to 1.00	0.75	0.83	0.85	0.97
Si	0.20 to 0.35	0.28	0.21	0.24	0.24
Ni	0.40 to 0.70	0.44	0.41	0.40	0.47
Cr	0.40 to 0.60	0.53	0.42	0.46	0.43
Mo	0.20 to 0.30	0.22	0.25	0.22	0.27
Grossmann's hardenability		3.81	3.76	3.86	4.63

The three heats of 8740 marked WE, XF and WG were tested longitudinally at positions 1 in., 2 in., and 3½ in. from center. Averages are shown in the table although there was a consistent difference, edge to center. Ultimate strength was about 3500 psi. lower at the center, proof stress and 0.1% yield strength 5000 psi. lower at center, elongation and reduction of area tended a little lower at the center (although there was no consistent difference in some bars, with the exception of one which had quite low ductility in center section). Charpy impact was substantially independent of position of longitudinal bar.

Heat WI with manganese on the high side (and with the greater hardenability of 4.63 in.) is listed separately in the large table because the properties of annealed 8-in. rounds are of a different order of magnitude. Longitudinal values are relatively independent of position except after the 1500° draw, obviously too high.

The original paper included tests on two heats of 8740 (hardenability about 4.55 in.) tested in the form of 1-in. rounds. After drawing at 1200 and at 1300° F. the 1-in. bars had about 12,000 psi. higher ultimate, 25,000 psi. higher proof stress, and 0.1% yield strength, 3% lower elongation and about the same reduction of area as heat WI.

NE8745—Four heats were tested in the form of 7 or 8-in. rounds; they were delivered as 8744, 8749 or 8949, but all fall neatly in the present specification, as shown below.

	Specification	WY	XS	VF	XE
C	0.43 to 0.48	0.44	0.44	0.46	0.44
Mn	0.75 to 1.00	0.84	0.97	0.81	1.00
Si	0.20 to 0.35	0.26	0.23	0.40	0.21
Ni	0.40 to 0.70	0.45	0.41	0.49	0.41
Cr	0.40 to 0.60	0.48	0.42	0.44	0.34
Mo	0.20 to 0.30	0.23	0.23	0.24	0.30
Hardenability					
Jominy (1½ in. from end)		C-38	C-37	C-34	C-37
Grossmann		4.28	4.41	4.66	4.74

There appeared to be no consistent variation, edge to center, in the longitudinal specimens. Likewise there seemed to be no correlation between Grossmann hardenability and test results, except after the 1200 draw, when the variation (if any) was opposite from that to be expected — that is, Heat XE with highest hardenability had the poorest properties. There are no comparable results in 1-in. specimens, as all the latter heats contained 0.32 to 0.36% Mo, considerably outside specification, being thus like the obsolete NE8949.

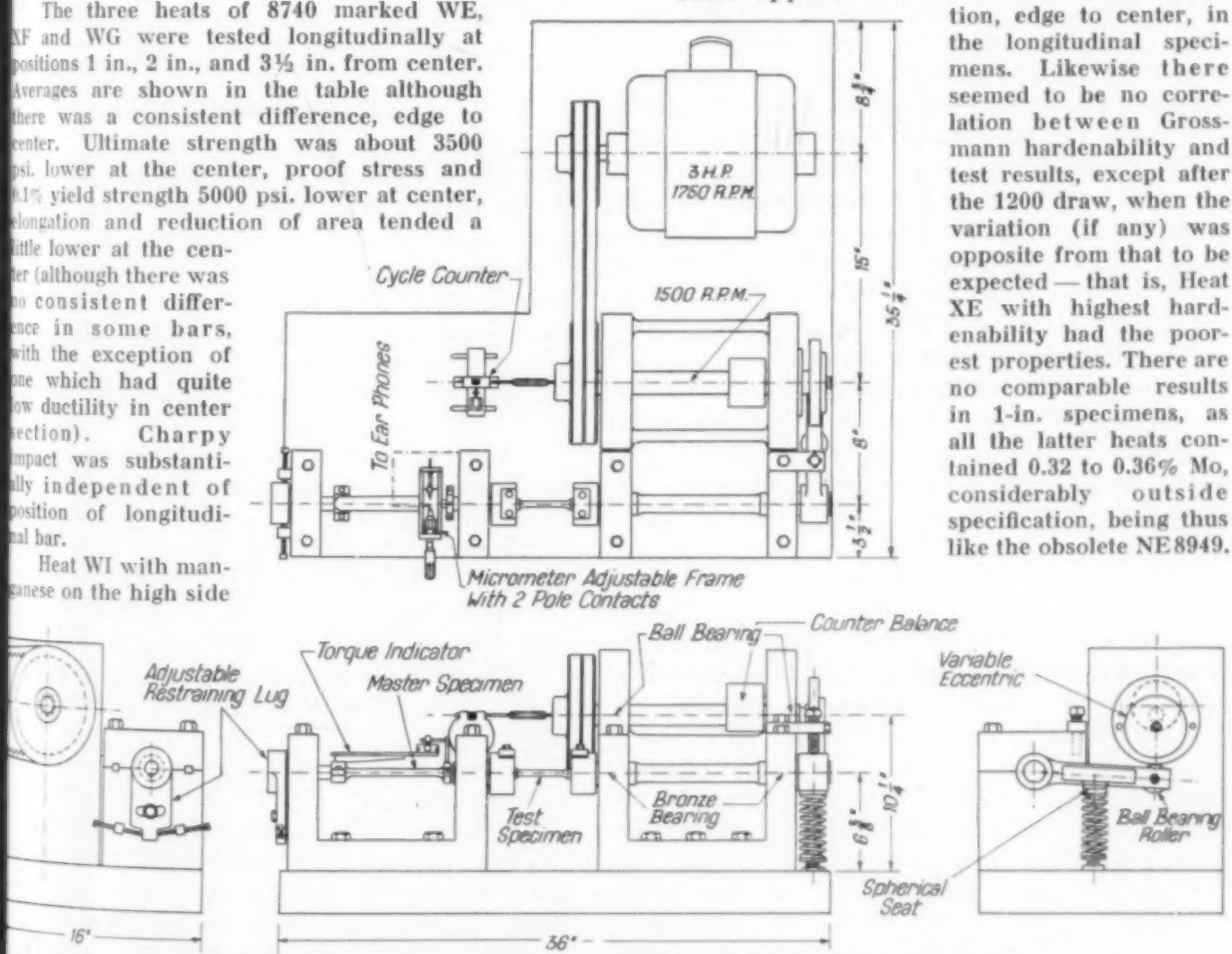

Fig. 1 — General Drawing of Alternating Torsion Fatigue Testing Machine

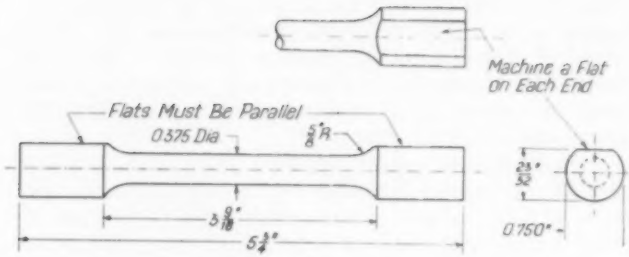

Fig. 2 — Modified Specimen for High Speed Alternating Torsion Machine

Author's Interpretation

It will be noted that in general forgings 8 in. in diameter made of steels of the lower carbon ranges investigated can be normalized and drawn so as to conform to the requirements of Class An, and those of the higher carbon ranges of Class HG. There are a number of marginal cases and it will be evident that for some of the steels, specification requirements can be met by adjusting the tempering temperature.

The average endurance ratio (ratio of endurance limit to tensile strength) for the 20 steels tested in rotating flexure is 0.43, and the corresponding ratio in alternating torsion 0.29. While the average endurance ratio for the alternating torsion tests compares favorably with endurance ratios obtained for alloy steels such as 3½% nickel steel, the average ratio for the rotating flexure tests is somewhat lower. In this respect, the NE steels tested behave more like carbon than alloy steels. In normalized and tempered steels the best endurance ratios range from 0.44 to 0.47. In general, good endurance ratios followed the 1300° F. temper.

End-quench hardenability tests were made on all the steels, but inasmuch as they conform in general to the curves already published for these steels, it is not considered necessary to reproduce them here.

Conclusions

National Emergency Steels of the 8000 series herein described offer much promise as alternate materials for forgings, classes An and HG, of Navy Department Specification 49S2. Of the four steels of this series, one is of the semi-thorough hardening grade, (NE8630) and the others of the thorough-hardening grade. All have shown to good advantage when properly heat treated. Of the less hardenable steels, NE8740 is a good representative material. Of the steels of greater hardenability, NE8749 has shown good properties in 1-in. sections.

These steels are well adapted for heat treatment by normalizing and tempering. This procedure is desirable for large sections and the tempering temperature is not critical. (The tempering temperature is more critical after oil quenching smaller sections.) In general, desirable properties can be obtained by normalizing and tempering at 1200 to 1300° F.

Steels NE9445 and 9450 are less satisfactory and failed to meet either An or HG requirements when normalized and tempered at 1200° F. However, the 9445 steel meets An requirements when tempered at 1300° F. Steel NE9450 failed to meet either An or HG requirements when normalized and then tempered at 1200 or 1300° F.

None of the samples showed any excessive amounts of non-metallic inclusions. Likewise, no flakes or cracks were encountered in the forgings.

At the present stage of investigation, it appears that some of the NE steels, as well as other steels containing smaller amounts of alloy than were customarily used under peace-time conditions, are capable of developing properties which are satisfactory for use in some applications in the naval service.

Credit for 1944 Covers

THE EDITOR feels that considerably more credit is due to several firms which have generously assisted in solving the problem of one-cover-a-month for *Metal Progress* than has been tendered on the respective Table of Contents pages, so he here acknowledges the indebtedness of the ⊜ for the following:

Plates for "To a Nazi Bomber it's the Kiss of Death", from Koppers Co., used in March.

Kodachrome negative of aircraft control mechanisms, from Consolidated Vultee Aircraft Corp., used in May.

Plates for view of teeming steel, from Kaiser Co., Inc., used in September.

Plates for view of melt shop, from Rustless Iron & Steel Corp., used in November.

Kodachrome microphotograph of manganese bronze, from Bausch & Lomb Optical Co., used this month.

Adaptations of these for our use were made by Earl J. Neff.

Artists who made the original designs for the other issues are: Russell Eisenhut (January); Edward D. McDonald (February); Flora Robb (April); Margaret Koncz (June); Carl Sorenson (July); Charles Lakofsky (August); Gloria Morgan (October).

Some Needed Precautions When Induction and Flame Hardening

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Surface hardening after carburizing produces parts with residual compressive stresses at the surface — a very desirable condition to enhance fatigue resistance against alternating loads in bending or torsion. Flame hardening produces lower surface compressions, and an underlying layer in tension dangerous to fatigue resistance. Induction hardening acts in a similar way, but the extent of this zone in tension can be limited by controlling frequency and power input.

THE METALLURGIST or the engineer who specifies induction hardening or flame hardening for highly stressed machine parts may find himself in trouble with fatigue failures. This risk of weakening machine parts by these localized surface hardening processes is due to trapped tension stresses in the hardened layer and to reduced hardness of the adjacent non-hardened material. These effects are the natural result of the highly localized heating and cooling operations and they will be serious fatigue hazards so long as the quality is judged solely by surface hardness.

We have ample evidence that surface hardening by flame heating and by induction heating merits the serious consideration that it is receiving for many new production items. It therefore seems appropriate that we critically analyze these hardening processes to discover, if possible, the results that may be expected from the several types of hardening equipment that are being offered. The data now at hand are too meager for complete evaluation of induction and flame hardening equipment and processes and, therefore, the discussion that follows is based upon studies of these processes as now practiced together with studies of other heat treating processes that most nearly resemble them.

Surface hardening is applied to machine parts for the purpose of

1. Resisting destruction of the surfaces as by wear, scoring or corrosion.
2. Increasing the fatigue strength of highly stressed machine members.
3. Combinations of wear or corrosion resistance and increased fatigue strength.

The following discussion will be concerned only with the effect of superficial quench-hardening on the fatigue strength of the part.

Fatigue strength of machine parts of any hardness is increased when the regions that are stressed in tension by the operating loads are residually stressed in compression. This increase in strength is obtained because

1. The surface of any specimen is more vulnerable to fatigue fracture than underlying layers.
2. Fatigue failures result only from tension stresses.

We may, therefore, greatly increase the durability to alternating loads (endurance) by inducing residual compressive stress in regions that are stressed in tension by the operating loads, since we thereby reduce the stress (tension) that causes fatigue failure. This is particularly true for parts that are loaded in bending or in torsion;

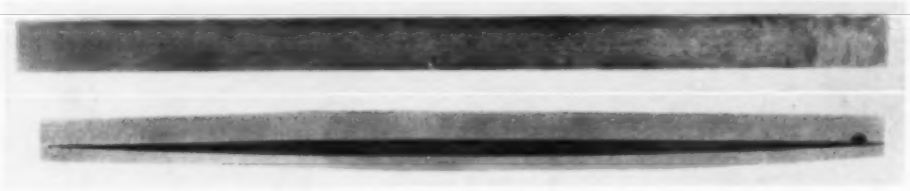


Fig. 1 — Top Is Side View of ½-In. Square Carburized on Two Opposite Faces Only, and Below Is Same Bar After Splitting Longitudinally. Bow is caused by compressive stresses trapped in carburized surfaces by carburizing and hardening

we can profit less by compressive pre-stressing for members stressed in direct tension.

Intentional introduction of residual stress to increase the fatigue strength of machine parts has been practiced for a very long time but the processor has rarely understood that the added strength was due to favorable internal stresses. To most of us residual stresses are undesirable because we only know that they cause warpage and occasional fractures during heat treatment and premature fatigue failures of parts in service. It can be shown, however, that residual stresses are not bad; it is only our failure to understand them and to use them properly that makes them seem bad. Like the sailor who has learned to use "adverse" winds to his own advantage, so must we learn to use residual stresses to the advantage of our structural materials.

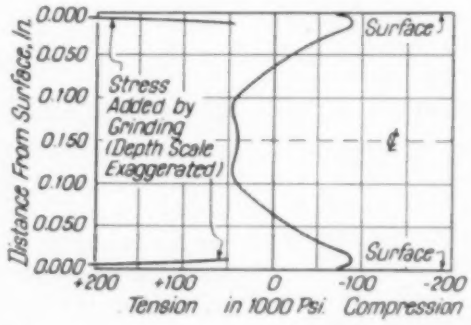


Fig. 2 — Residual Stresses Actually Measured in Hardened Gear Tooth (Carburized) Approach 100,000 Psi. Compression at Surfaces, and Can Be Increased 50% by Shot Peening

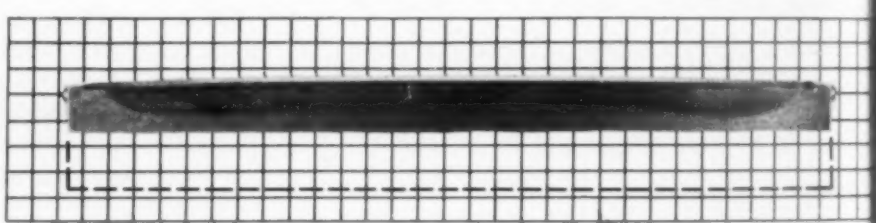


Fig. 3 — Compressive Stress of About 40,000 Psi. Causes a Small Segment Cut From an Induction Hardened Journal Bearing 6 In. Long to Take an Upward Bow. Original thickness shown by dotted line

In modern practice, compressive pre-stress is obtained by mechanical manipulation and by heat treating. Thus, springs are "pre-set", meaning that they are stressed beyond the yield strength a few cycles; because of yield, this induces residual stresses in the springs when the external load is removed. This is done because of the known improvement in fatigue durability that results. Similarly, springs, gears and other parts are improved by shot blasting, tumbling, and sometimes by straightening because these operations induce compressive residual stresses to counteract tension stresses in operation.

Compressive residual stresses in the surface layers are also obtainable by carburizing, nitriding, induction hardening, flame hardening and by severe quenching. The well-known improvement in fatigue strength that results from these treatments, when they are properly applied, is largely a matter of the residual stress pattern that is obtained. However, it is also possible to obtain the *wrong* distribution of residual stress, in which case the fatigue strength of the part is decreased. Rather than issue blanket condemnations of all residual stress in applying processes in which the wrong distribution can be obtained, we must surround the operation with suitable safeguards so that we encourage good practices and avoid bad ones.

The point can perhaps best be clarified by reference to our common experiences. Carburized parts are fatigue resistant because, through increased hardness, the strength of the outer carburized layer is increased and also because the carburized layer is highly stressed in compression. The compressive stress in the carburized layer is the result of thermal contraction of the outside layers upon quenching, and the increased volume of the hardened layer.

Let us see how this comes about:

When a cylindrical heated part is quenched, the contraction of the outer layers stresses the still plastic inner material beyond its yield strength and this inner material is, therefore, "upset". As the cooling proceeds, the inner material also contracts, drawing down upon the outer shell which compressively stresses these outer

layers with corresponding tension stress in the inner material. Also, because of the increased carbon content of the carburized layer, this layer is transformed during the quench to a material (martensite) of *greater volume* which augments the surface compressive stress that was obtained by the thermal contraction.

The residual stress in a carburized bar is graphically illustrated in Fig. 1, showing at left a ½-in. square bar that is carburized on two opposite faces, carburization of the other two faces being stopped off by copper plating. The same bar, split with a saw after hardening, is shown at right. The curving of the two halves of the bar is the result of compressive residual stress in the outer layers and the balancing tension residual stress in the core material.

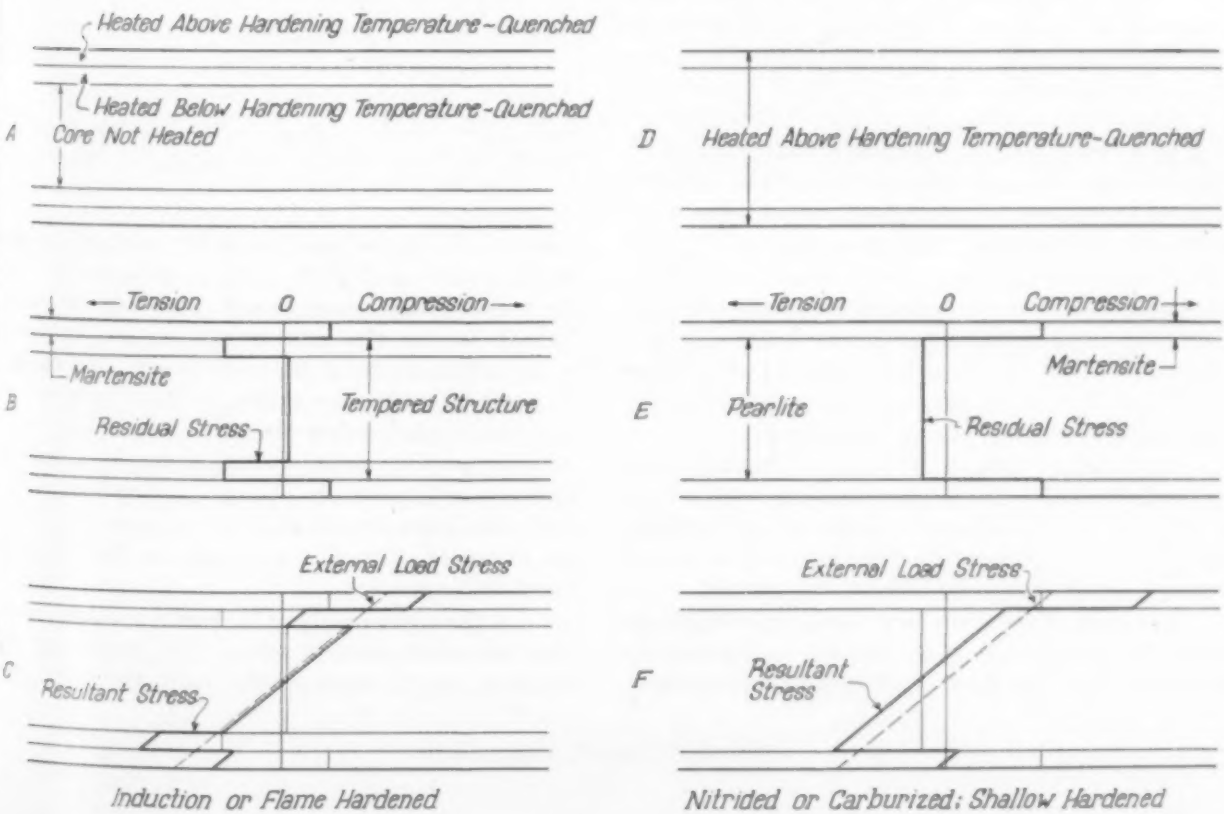
Figure 2 shows a diagram of the actual residual stress that existed in a carburized gear tooth. Here we see that the carburized layer is stressed in compression to approximately 90,000 psi. and the core is stressed in tension to approximately 50,000 psi. The stress in this gear tooth was measured by removing successive layers and measuring the change in length and in curvature of the remaining material as each layer was removed. Note the tendency for stress reversal toward tension at the surfaces. The reason for this reversal may be the result of retained austenite, decarburization, or similar influences. The great improvement in fatigue durability that is obtainable by shot peening carburized gears is due to the increase of the compressive stress in the outermost layers from less than 90,000 psi. to something like 150,000 psi.

In flame heating and induction heating processes, the sequence of events is reversed from that of carburizing and, therefore, the stress in the surface material, due to thermal contraction, is tension instead of compression. In such surface heating, the outer material becomes plastic while the inner material is cool and rigid. The hot outer layer wants to expand but, being restrained by the cold inner material, this hot layer is plastically deformed. Upon cooling, the thermal contraction of the deformed outer layer on the cool unyielding inner core results in tension of this layer and the part is, therefore, weak in fatigue as ordinarily understood.

However, when hardenable steel is quenched from above the hardening temperature it experiences a phase change upon cooling to a material (martensite) of greater volume. This volume increase, by itself, produces compressive stress in the transformed layer.

It follows that the net surface residual stress in surface hardened steel is the algebraic sum of the tension stress produced by the thermal contraction and the compression stress produced by the transformation. In specimens that have been measured, it has been found that the surface was compressively stressed to about 30,000 to 40,000

Fig. 4 — Diagram of Surface and Sub-Surface Stresses in Round Bar Resulting From Surface Hardening (A, B and C at Left) and From Carburizing or Nitriding to an Equally Shallow Depth (D, E and F at Right)



psi. Figure 3 on page 1264, for example, shows a section of an induction hardened crankshaft in which the stress has been analyzed in the same manner that was described for the gear tooth of Fig. 2. Note that this induction hardened specimen is curved convex on its upper surface, indicating a desirable compressive stress in the hardened layer.

We have described the several events that take place in the hardened layer of a surface hardened part as a result of heating and quenching (no carburizing). We must now consider what happens to the material immediately below that which was heated above the hardening temperature. We may imagine three zones as is shown in Fig. 4-A, an outer layer that is heated above the hardening temperature, a second layer that is heated below the hardening temperature, and the core material that is not heated at all.

The outer layer, which is quenched from a temperature above that required for hardening, is compressively stressed as is shown in Fig. 4-B by virtue of the transformation that occurred upon hardening. However, the second layer does not experience this transformation, although it was hot enough to be effectively annealed and thereby weakened. Upon cooling, it experiences only the thermal contraction and this layer will be stressed in tension, as is also shown in Fig. 4-B.

When such a specimen is stressed by an external load, as is shown in Fig. 4-C, the second layer is very highly stressed in tension since the stress in this zone is the sum of the tension stress from the external load and the residual tension that resulted from the thermal contraction. Since fatigue failures result only from tension stresses, this second zone is vulnerable to fatigue, particularly if it emerges to the surface as at the end of a hardened zone or at the overlap of two passes of a hardening flame. When this highly stressed layer is exposed, it is doubly vulnerable because it then is subject to the added stress raisers of surface irregularities. The emergence of the second zone to the surface occurs when local areas are hardened, as on crankshaft journals, or gear tooth flanks, or when a previously heated area is reheated — that is, when the surface is too large to be heated at one time or when it cannot be continuously heated in one direction.

The loss of fatigue strength of an induction hardened crankshaft is shown in the S-N chart in Fig. 5. Fatigue failure occurred by bending stress in the vicinity of the fillet where the second zone emerged to the surface of the journal.

Contrast these surface heating conditions with the conditions that prevail in specimens hardened by nitriding, carburizing, or severely quenched shallow hardening steel as is shown in the charts of Fig. 4-D, E and F. There is no "second zone effect" because the direction of heat flow is opposite to the heat flow in induction and flame hardened parts. The resultant operating tension stress, which normally causes fatigue failure, is therefore much lower. Also there is no annealed material below the hardened layer, and this underlying material is stronger than the annealed material in induction or flame hardened specimens.

Whereas flame hardening and induction hardening may be harmful to fatigue strength, we should look for means to reduce this effect or to eliminate it altogether. For example, in Fig. 6 are etched sections of two gears that have been hardened so as to obtain widely different effects. The gear at the left was heated at a low rate and by relatively low frequency current. The outer

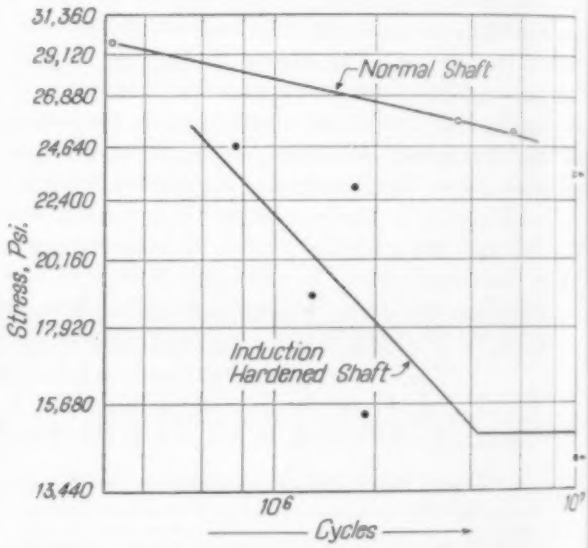


Fig. 5 — Endurance Tests on Crankshafts; "Normal" Was Carburized and Quenched. (Williams and Brown, Engineering, Vol. 154)

(hardened) zone includes practically all of the tooth and the second zone is prominent near the root. This gear would probably be satisfactory where strength is not needed but only resistance to wear or corrosion. Its fatigue strength would presumably be low because the high residual tension stress in the second zone would combine with operating bending tension stresses, as shown in Fig. 4-C. Remember also that this high resultant tension stress is acting on annealed material and not on the stronger hardened material.

At the right in Fig. 6 is shown another induction hardened gear in which the frequency was so high as to successfully heat the root area

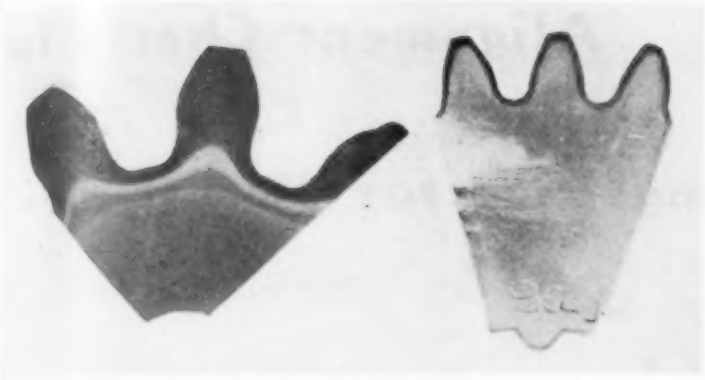


Fig. 6 — Widely Varied Hardness Patterns of Gears Hardened by Induction

5 in.	Diameter	4 in.
	Width	¾ in.
2 in.	Pitch	8½ in.
153,000	Frequency	450,000
28 kw	Input	58 kw.

while affecting the flanks and tips of the teeth much the same as is produced by carburizing. Also the rate of heat input was great enough to reduce the second zone to very small proportions. Note that similar effects are produced on the spline at the center of the gear. This gear would be equal to the gear shown at the left in resistance to wear and corrosion and would, presumably, be very much stronger in bending fatigue because of the reduced second zone effect.

Many gears are flame hardened on the side, from root to edge of tooth only, somewhat as is shown in Fig. 7. This hardness pattern is more detrimental to fatigue strength than the one shown at the left of Fig. 6 because the second zone comes to the surface at the root of the tooth where the bending stress is greatest.

These illustrations, Fig. 6 and 7, indicate that we should not install surface hardening equipment until we have determined the effects that are desired and how they may be obtained. If highly loaded gears are to be hardened by induced electrical currents we should presumably use very high frequency equipment with a high power input. The high frequency is necessary to produce a satisfactorily hardened case at the root of the tooth. High power is necessary to increase the heat gradient and thereby decrease the thickness of the second zone, a tension stressed layer.

For small gears the equipment should be capable of heating the *entire* toothed periphery, because if the gear is heated in sections it would be necessary to form one or more junctions between the previously heated and the newly heated sections. When this junction is formed at the root of the tooth there will be a severe disturbance of the previously heated material with a loss of surface compression and, therefore, fatigue strength. If this junction is made at the tip of the tooth a similar disturbance will occur but this will be in a region of low stress and, therefore, not harmful unless it affects the hardness at the tooth tip (in which case the scoring resistance of the tooth will be adversely affected).

The danger of "second zone fatigue vulnerability" is by no means confined to gear teeth and crankshafts. It is present in all highly loaded machine parts where the bending or torsion loads are high and the hardened layer is relatively shallow. It is particularly harmful where the hardening is localized so as to bring the second zone to the surface, as occurs in local induction hardened journals or when flame or induction heat is applied to hard surfaces to soften local areas. Likewise it is an effect that has long been known to the makers of case carburized parts (gears and roller bearings) and is guarded against by proper mutual adjustment of depth of case and strength of underlying core to the loads that must be carried by the machine part.

In flame hardening the temperature gradient

Fig. 7 — Frequent Pattern of Flame Hardened Metal on Faces of Teeth (No Hardening at Root)

is lower than can be obtained by induction heating and, as a consequence, the second zone effect cannot be reduced to the same extent as is possible by high frequency induction hardening. The harmful second zone effect can, of course, be avoided by heating to such depth, whether it be by flame, by resistance, or by induction, as to approach heating all the way through — as is done in the ordinary furnace. This method of heat treating has considerable merit as a means of quick heating to avoid decarburization, but it is not in the class of surface hardening treatments discussed in this article.

Alignment Charts for

Bending Dies for 18-8 & 17-7

By C. M. Brown and W. O. Binder
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IN THE LAST ISSUE of *Metal Progress* (page 1077 e.s.) methods for computing springback of stainless sheet and strip were developed with the aid of elastic theory and experimental stress-strain curves of sheet (either annealed or cold rolled) when stretched repeatedly into the plastic range yet without breaking the sample. The utility of such information in the design of bending dies to produce given shapes (when springback is allowed for) and the opposite case of predicting what an existing die will produce when operating on cold rolled stainless steels of various "tempers" was demonstrated.

As a simplified method of solving bending and forming problems, the use of the alignment charts is now proposed. A factor b, shown in the text on the four charts, pages 1270, 1271, 1272 and 1272-B permits them to be used for steels cold drawn to different yield strengths. This factor is derived from the left hand diagrams in Fig. 3 and 4 of last month's article.

These alignment charts show the three variables:

1. Finished part angle degrees (θ_r)
2. Die angle degrees (θ_t)
3. Total strain in outer fiber ($e_t = \frac{T}{2R_t}$)

If two of the three variables are known, the third may be found by drawing a straight line between the two known points and determining the intersection of this line with the third axis. As an example, assume that a desired part is to be made of 0.04-in. thick annealed 18-8 steel sheet, is to have a finished flange angle of 90° and is to be bent around a die radius of 0.12 in. The problem is to find the total angle of bend (die angle).

$e_t = \frac{T}{2R_t}$ is first computed where

$T = 0.04$ in. and

$R_t = 0.12 \text{ in.} + \frac{0.04 \text{ in.}}{2} = 0.14 \text{ in.}$

(the radius to the neutral axis)

Then $e_t = \frac{0.04}{2 \times 0.14} = 0.143$ in. per in.

$\theta_r = 90°$ (the finished or residual angle).

In completing the solution of the problem the alignment chart on the opposite page is used. A straight line connecting the two known values — i.e., θ_r and e_t — intersects the θ_t axis at 92.5°, the total angle through which the part must be bent. (The assumption that circular bending takes place has been made in this example.)

The alignment charts are set up for use when the quantity $e_t = \frac{T}{2R_t}$ is known. If it is desired to determine the die block dimensions, the finished part radius, R_r, and $e_r = \frac{T}{2R_r}$ being known, it is necessary to assume that R_r is approximately equal to R_t. This is nearly true for sharp bends. It is not, however, true for parts with large radii. In this case values of e_t are assumed and the solution worked out, then another assumption made until the assumed value of e_t satisfies the relation $\frac{e_r}{e_t} = \frac{\theta_r}{\theta_t}$.

Circular Bends on Annealed 18-8

Alignment Chart

For use in calculating the circular bending properties of 18% Cr, 8% Ni steel sheet and strip in the annealed condition, 36,000-psi. longitudinal tensile yield strength.

θ_r = Finished part angle, degrees
θ_t = Die angle, degrees
e_t = Total strain in outer fiber, in. per in.
T = Thickness, in.
R_t = Die radius + ½ sheet thickness, in.

Example

Assume: Annealed sheet 0.04 in. thick ($T = 0.04$)
Die radius 0.12 in.

Then: $R_t = 0.12 + \frac{1}{2}\ 0.04 = 0.14$ in.

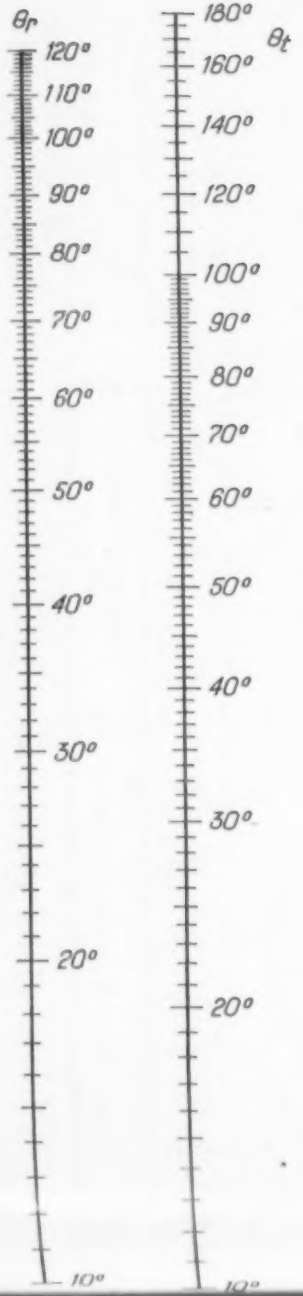
$$e_t = \frac{T}{2R_t} = \frac{0.04}{2 \times 0.14} = 0.143 \text{ in. per in.}$$

(Point A on right hand line)

Assume: Finished or residual angle of bend = 90°
That is, $\theta_r = 90°$

(Point B on left hand line)

Solution: Draw straight line between Points A and B; intersection with third line gives 92½° for θ_t, the required die angle, or bend that must be imposed on this material to allow for correct angle of part after springback.



Alignment Chart for use in calculating the circular bending properties of 18% Cr, 8% Ni steel sheet and strip cold rolled to 115,000-psi. longitudinal tensile yield strength.

θ_r = Finished part angle, degrees
θ_t = Die angle, degrees
e_t = Total strain in outer fiber, in. per in.
T = Thickness, in.
R_t = Die radius + ½ sheet thickness, in.

Proceed as indicated in chart for annealed 18-8 (page 1269) to determine θ_r or θ_t, as the case may be.

Conversion Formulas for Steels of Different Yield Strengths: After finding the approximate resultant θ_r or θ_t from the chart, correct this angle according to the proper yield strength of the material, as follows.

Case I: Where a die is to be made,

$$\theta_t' = \frac{\theta_r}{1 - \frac{b(\theta_t - \theta_r)}{0.0105\,\theta_t}}$$

θ_t' = Corrected die angle
b = Value of factor corresponding to yield strength from table below
θ_t, θ_r As defined above

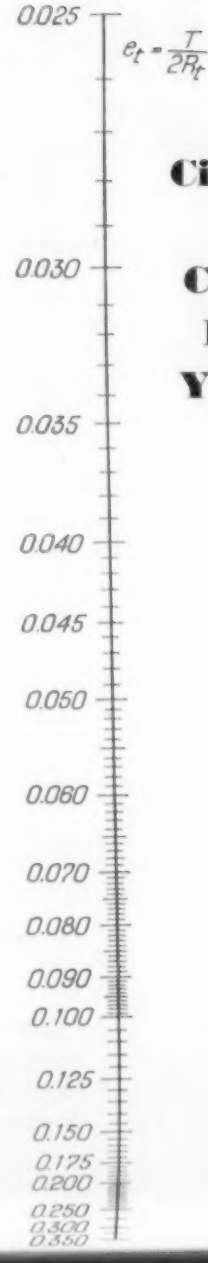
Case II: Where a die is available

$$\theta_r' = \theta_t - \frac{b}{0.0105}\,(\theta_t - \theta_r)$$

θ_r' = Corrected residual angle in part when formed over given die
θ_t, θ_r, b As defined above

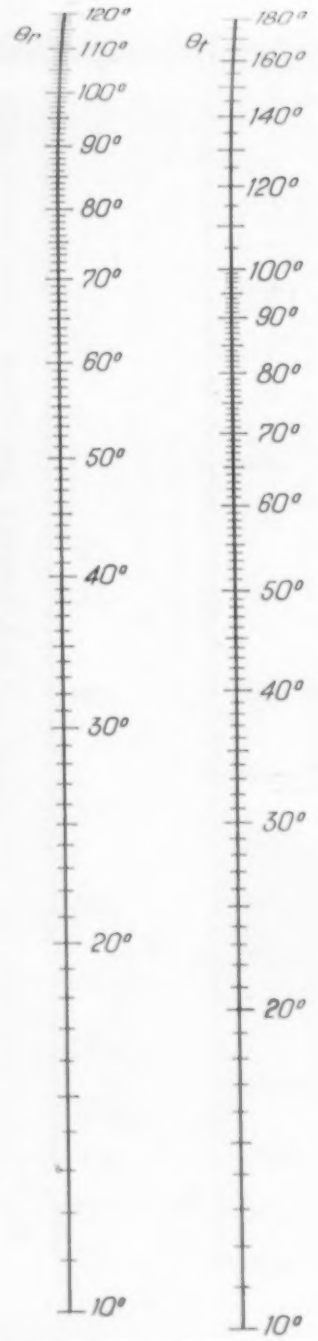
Factors for Steels Cold Rolled to Different Yield Strengths

Yield Strength	b
75,000 psi.	0.0076
85,000	0.0082
95,000	0.0088
105,000	0.0095
115,000	0.0105



Circular Bends on 18-8, Cold Rolled to 115,000-Psi. Yield Strength

Circular Bends on 18-8, Cold Rolled to 126,000-Psi. Yield Strength



Alignment Chart for use in calculating the circular bending properties of 18% Cr, 8% Ni steel sheet and strip cold rolled to 126,000-psi. longitudinal tensile yield strength.

θ_r = Finished part angle, degrees
θ_t = Die angle, degrees
e_t = Total strain in outer fiber, in. per in.
T = Thickness, in.
R_t = Die radius + ½ sheet thickness, in.

Proceed as indicated in chart for annealed 18-8 (page 1269) to determine θ_r or θ_t, as the case may be.

Conversion Formulas for Steels of Different Yield Strengths: After finding the approximate resultant θ_r or θ_t from the chart, correct this angle according to the proper yield strength of the material, as follows.

Case I: Where a die is to be made,

$$\theta_t' = \frac{\theta_r}{1 - \frac{b(\theta_t - \theta_r)}{0.0129\,\theta_t}}$$

θ_t' = Corrected die angle
b = Value of factor corresponding to yield strength from table below
θ_t, θ_r As defined above

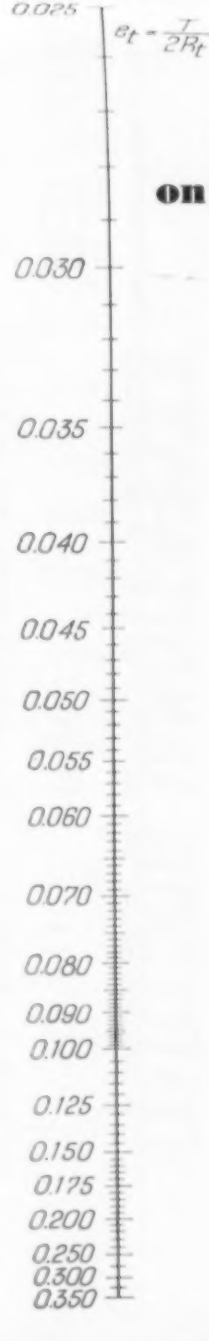
Case II: Where a die is available

$$\theta_r' = \theta_t - \frac{b}{0.0129}\,(\theta_t - \theta_r)$$

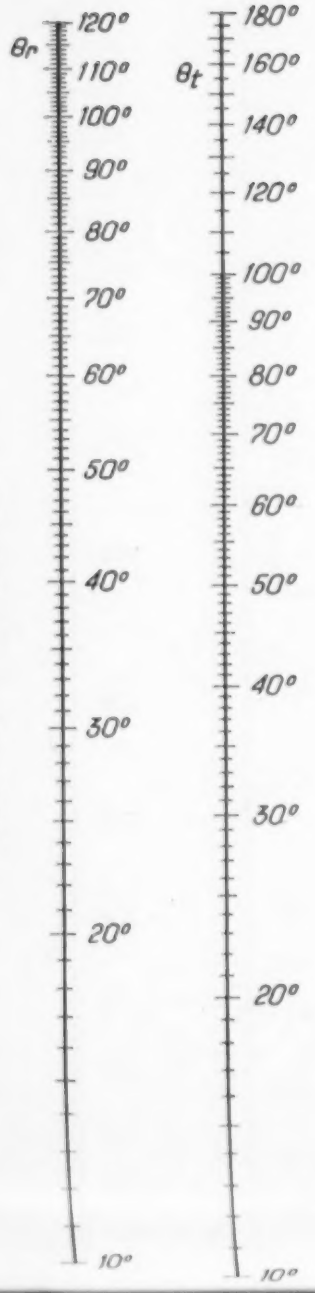
θ_r' = Corrected residual angle in part when formed over given die
θ_t, θ_r, b As defined above

Factors for Steels Cold Rolled to Different Yield Strengths

Yield Strength	b
120,000 psi.	0.0111
123,000	0.0118
126,000	0.0129



Circular Bends on 17-7, Cold Rolled to 124,000-Psi. Yield Strength



Alignment Chart for use in calculating the circular bending properties of 17% Cr, 7% Ni steel sheet and strip cold rolled to 124,000-psi. longitudinal tensile yield strength.

θ_r = Finished part angle, degrees
θ_t = Die angle, degrees
e_t = Total strain in outer fiber, in. per in.
T = Thickness, in.
R_t = Die radius + ½ sheet thickness, in.

Proceed as indicated in chart for annealed 18-8 (page 1269) to determine θ_r or θ_t, as the case may be.

Conversion Formulas for Steels of Different Yield Strengths: After finding the approximate resultant θ_r or θ_t from the chart, correct this angle according to the proper yield strength of the material, as follows.

Case I: Where a die is to be made,

$$\theta_t' = \frac{\theta_r}{1 - \frac{b(\theta_t - \theta_r)}{0.0120\ \theta_t}}$$

θ_t' = Corrected die angle
b = Value of factor corresponding to yield strength from table below
θ_t, θ_r As defined above

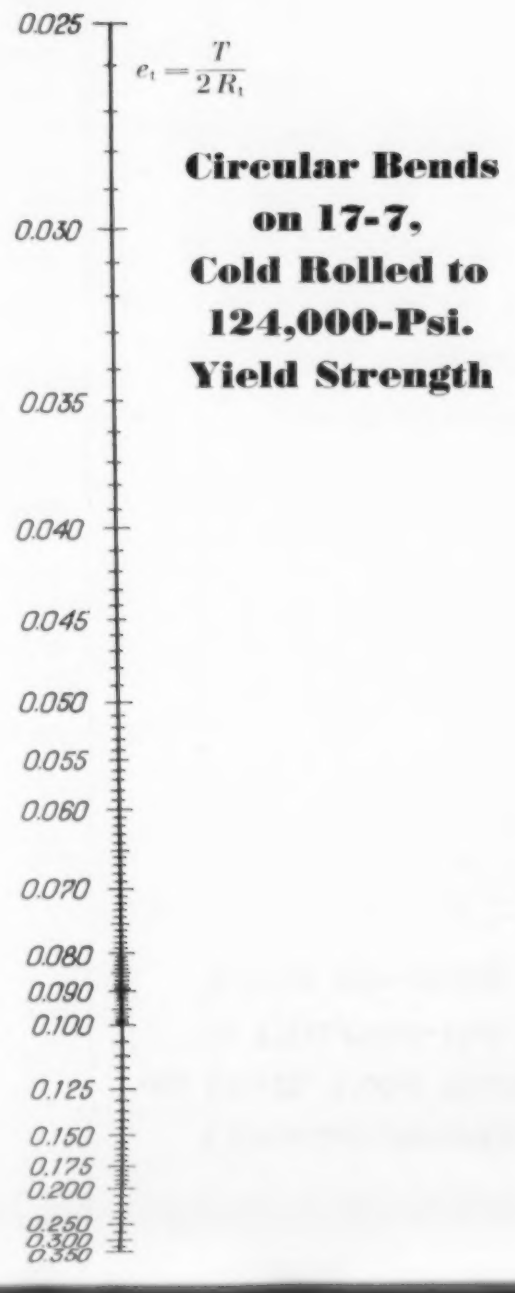
Case II: Where a die is available

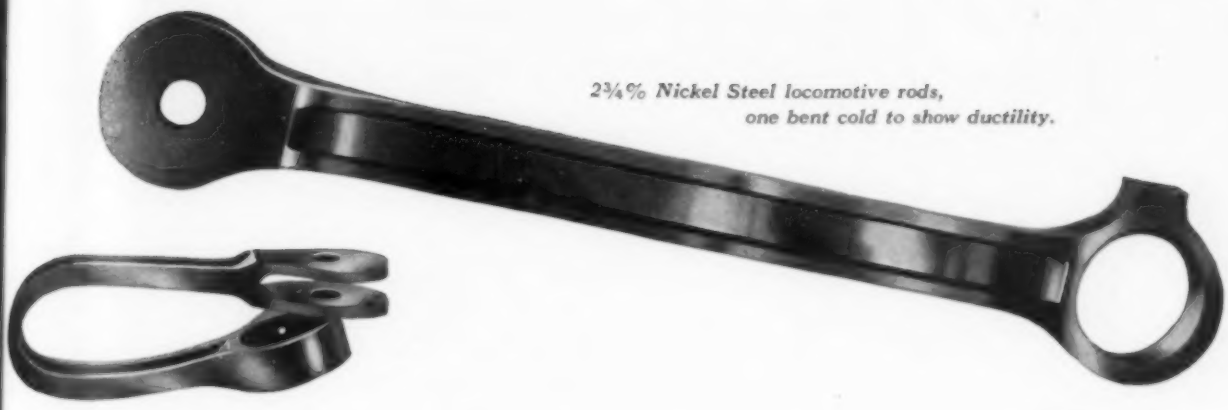
$$\theta_r' = \theta_t - \frac{b}{0.0120}\ (\theta_t - \theta_r)$$

θ_r' = Corrected residual angle in part when formed over given die
θ_t, θ_r, b As defined above

Factors for Steels Cold Rolled to Different Yield Strengths

Yield Strength	b
110,000 psi.	0.0106
117,000	0.0113
124,000	0.0120
130,000	0.0127
135,000	0.0133





2¾% Nickel Steel locomotive rods, one bent cold to show ductility.

UENCHED AND TEMPERED NICKEL STEEL FORGINGS COMBINE

EXCEPTIONAL DUCTILITY WITH HIGH TENSILE STRENGTH

Composition and Typical Properties of Normalized Quenched and Tempered 2¾% Nickel Steel Rods

Description or Size	Melt Yield Pt. No. #'s per Sq. In.	Tensile Strength #s per Sq. In.	Elong. % in 2 In.	Reduction in Area %	ANALYSIS					
					Car.	Mang.	Phos.	Sul.	Sil.	Ni
Main Rod....	92900	110000	25.0	64.4	.31	.78	.027	.026	.25	2.75
Main Rod....	86500	104500	25.5	65.6	.32	.86	.034	.032	.29	2.69
Main Rod....	86360	104400	26.0	64.8	.32	.86	.034	.032	.29	2.69
Main Rod....	87850	102350	26.0	66.2	.31	.89	.037	.025	.32	2.69
Front Rod....	86000	102250	25.0	67.3	.29	.82	.035	.027	.24	2.71
Front Rod....	83900	104250	25.0	66.1	.29	.82	.035	.027	.24	2.71
Front Rod....	86850	104250	27.0	66.1	.32	.86	.035	.025	.30	2.65
Front Rod....	89500	107050	25.5	65.6	.32	.86	.035	.025	.30	2.65
Back Rod....	89500	107650	25.0	62.7	.30	.79	.030	.025	.22	2.71
Back Rod....	87500	106450	25.0	65.4	.29	.82	.035	.027	.24	2.71
Back Rod....	87000	105600	25.0	65.4	.29	.82	.035	.027	.24	2.71
Back Rod....	88150	104850	26.0	66.8	.29	.82	.035	.027	.24	2.71

Specimens Taken from Mid-Section of Prolongations of the Forgings

The above table compiled by the American Locomotive Company shows the chemical compositions and mechanical properties of some normalized, quenched and tempered nickel steel front, main and back rods recently produced as replacement rods for locomotives being speeded up and rebalanced. These values are typical of replacement rod forgings recently tested by that company.

Quenched and tempered nickel steel forgings provide high tensile strength and ductility, combined with unusual toughness and high fatigue strength—qualities which tend to obviate breakage and assure long, trouble-free service when employed in heavy duty machinery and equipment.

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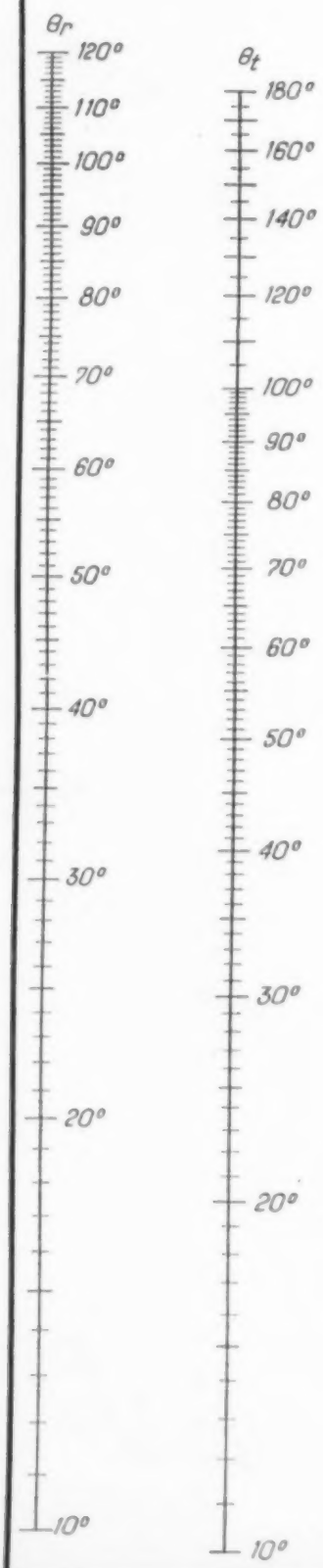
Alignment Chart for Circular Bends on 17-7

Cold Rolled to 151,000-Psi. Yield Strength

By C. M. Brown, W. O. Binder, Russell Frank



For use in calculating the circular bending properties of 17% Cr, 7% Ni steel sheet and strip cold rolled to 151,000-psi. longitudinal tensile yield strength.

θ_r = Finished part angle, degrees
θ_t = Die angle, degrees
e_t = Total strain in outer fiber, in. per in.
T = Thickness, in.
R_t = Die radius + ½ sheet thickness, in.

Proceed as indicated in chart for annealed 18-8 (page 1269) to determine θ_r or θ_t, as the case may be.

Conversion Formulas for Steels of Different Yield Strengths

After finding the approximate resultant θ_r or θ_t from the chart, correct this angle according to the proper yield strength of the material, as follows.

Case I: Where a die is to be made,

$$\theta_t' = \frac{\theta_r}{1 - \frac{b(\theta_t - \theta_r)}{0.0144\,\theta_t}}$$

θ_t' = Corrected die angle
b = Value of factor corresponding to yield strength from table below
θ_t, θ_r As defined above

Case II: Where a die is available

$$\theta_r' = \theta_t - \frac{b}{0.0144}\,(\theta_t - \theta_r)$$

θ_r' = Corrected residual angle in part when formed over given die
θ_t, θ_r, b As defined above

Factors for Steels Cold Rolled to Different Yield Strengths

Yield Strength	b
140,000 psi.	0.0138
145,000	0.0141
151,000	0.0144
160,000	0.0147
165,000	0.0148

Bits and Pieces

Metallurgicus's

Own Department

Quenching Oils

IN PREVIOUS ITEMS on this "Bits and Pieces" page, quenching equipment has been considered from various angles, principally that of getting the coolant to the work — in other words, giving it a chance to function. Pressure, fixture, or open tank quenching should all be done in the way that will produce the most uniform possible cooling at a rate high enough to harden the steel.

How effective circulation is in improving cooling rate of an oil is clearly shown by Grossmann's "H" value:

Circulation	"H" Value
None	0.25 to 0.30
Moderate	0.35 to 0.40
Strong	0.5 to 0.8
Violent	0.8 1.1

Violently agitated oil (that is, oil striking the hot work violently — not just some churned-up oil) is as effective as still water (H = 1) in hardening, and certainly offers far less hazard of cracking or distortion.

It is to be hoped that everyone concerned with quenching oils has read "An Evaluation of Quenching Oils" by Spring, Lansdale, and Alexander in *Transactions* for 1944 (Vol. 33, page 42), and the very informative discussion of this paper. The authors tested eight different oils, light, heavy, plain mineral, compounded, and found that if each oil were held at a certain best temperature for that oil all had about equal hardening power. These authors concluded that by properly regulating oil temperature they could do anything with common 10¢-a-gal. mineral oil that could be done with the much higher priced trade-marked oils.

In discussing this paper, Focke cited H values obtained by him on several oils without agitation; the highest was 0.44 for a proprietary oil. Grossmann's work, done with common mineral oil, shows clearly that a moderate change in degree of agitation is enough to wipe out the slight difference between the *still* H value he quotes of 0.30 and Focke's maximum figure of 0.44.

While I do not want to cut the ground out from under some of the business friends of this magazine (presumably they will be given space to show where I am wrong, if I am wrong) this is apparently the conclusion reached by many large users of quenching oil. For years the automobile manufacturers have used, for production quenching, oil with about these characteristics:

Flash point	325° minimum
Fire point	360° minimum
Saybolt viscosity at 100°	100 sec. (minimum)
Price	10¢ base, approximately

It has been found far more economical to provide the best possible quenching facilities, such as tanks, fixtures, presses, temperature regulation, and pumps — which once bought are paid for — than to skimp on these items and pay a much higher, never-ending price per gallon for the oil consumed.

Discussion of the above-mentioned paper brought out that there are borderline cases where hardenability of the steel is inadequate and a special compounded oil must be used, but as I have observed things, these special oils are too often used for no reason at all, or because the quenching facilities were not proper for the job.

There is a very good basic reason for using cheap oil: A small leak of water from the cooling system may contaminate the oil, and then there is only one thing to do — replace it. It has been shown that "salad-dressing" mixtures of as little as 0.5% water in oil will ruin its quenching power, to say nothing of the quantity of work that may be damaged. Oil is also frequently contaminated by salt carried over from salt baths.

One discussion of the paper mentioned above

(and by an oil salesman at that!) said, "All investigations along these lines made in recent years at plant laboratories and in heat treating departments have resulted in the same conclusions at which the authors have arrived."

One of the standard minstrel show jokes of the older generation ran like this:

Sam: "Mr. Bones, have you ever seen a portrait of John D. Rockefeller?"

Bones: "No, because John D. was never *done* in oil!"

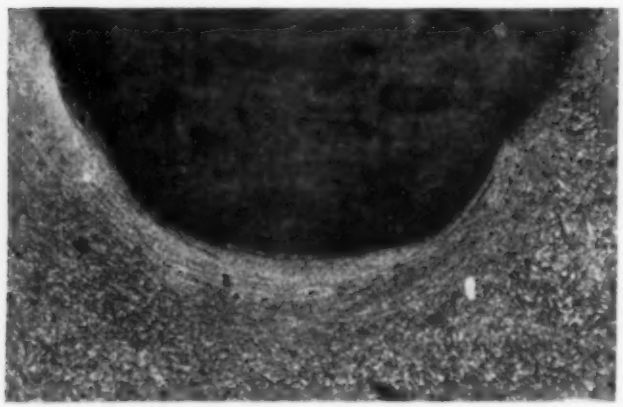
The user of quenching oil should be on guard to see that he is not "done" in oil, by making sure that he buys the oil which will do his work most economically; this oil may have to be a compounded proprietary oil, but such should not be bought until the fundamental principles of quenching have been explored and the necessity for something better than plain mineral oil ("100 at 100", 10¢-a-gal.) has been demonstrated.

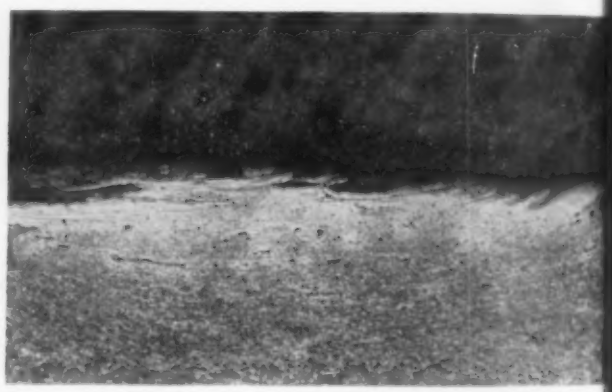
METALLURGICUS

Flaw Detection by Paint and Heat

AN amusing illustration of the old adage that there is nothing new under the sun is the method described by Berthold in *Metallwirtschaft* for 1941, page 525, for detecting flaws in metal by painting the surface of a metal part with thermal indicating paint and then heating the back. Internal flaws affect the heat flow and are indicated by the paint.

Gilbert White in his "Natural History of Selborne" (1788) refers to an observation dated 1731 by a Dr. Hales that field drains prevented the warmth of the earth from rising and thawing the surface frost, thus rendering visible the drains and similar cavities when the surrounding ground thawed out. White suggested this as a method of discovering hidden relics of antiquity but it is a surprising turn of events to find the method applied in modern metallurgy! (M. RIDDIHOUGH, Technical Manager, Deloro Smelting & Refining Co., Ltd., Birmingham, England)





Root of Thread and Longitudinal Section Along Hardened Side, Where Metal Was Locally Hardened by a Dull Cutter Used in the Form Milling Operation. Picral etched, magnified 175 diameters

"Hard Spots" From Dull Tools

METALLURGICAL CONTROL is forever being plagued by complaints of "hard spots" or defective material and I believe that many share the opinion that the difficulty frequently arises from dull tools. However, we are not always fortunate enough to cut the right spot to develop the necessary microscopic evidence to prove the point — I know that the following incident has been the only time that I have been fortunate enough to get the right location in the many times this type of trouble has arisen.

The important buttress thread on the shank of a steel propeller blade, a thread whose form and finish is critically maintained, is milled in X-4330 electric furnace steel, heat treated to Brinell 320. Thread hobs are of high carbon, chromium toolsteel, or chromium-tungsten toolsteel hardened to C-64 or C-65. Admittedly, the milling of the thread of the required quality on this material at the specified hardness is difficult, but by no means impossible.

During a recent epidemic of tool failures a number of broken hobs were examined microscopically, and blade shanks that had caused breakage were hardness checked and examined microscopically. No irregularities were found. Finally one blade shank was sectioned and it revealed the evidence we were looking for.

In processing the blade, a form cutter is used to mill the thread area inside the shank prior to the thread milling operation. The milling of the thread itself is accomplished in two cuts; a rough and a finish cut. Breakage of the hob occurred predominantly in the finish or light cut.

Our original theory was that the so-called "hard spots" were caused by localized hardening

from dull hobs. The two photomicrographs verified this fact. As can be seen, the grain flow at the bottom of the thread is badly distorted, showing working rather than cutting. The longitudinal view of the side of the thread shows localized hardening due to frictional heat and quenching by the coolant. Further investigation revealed that the hobs were properly ground but were dulled by making the first cut over the form-milled surface.

A close inspection of the condition of the form milling cutters was instituted, and the "hard spots in the steel" miraculously disappeared. (HARRIS P. MOYER, Chief Metallurgist, American Propeller Corp.)

Model Construction

AN interesting account of methods for constructing space models representing equilibria in ternary alloy systems, written by E. M. Smith in *Metal Progress* for March, is reminiscent of a paper in the *Journal* of the Institute of Metals, written 24 years ago by the late Walter Rosenhain. He used stiff wire, as described by Mr. Smith, for representing binary phase boundaries, and colored wire instead of thread for the elements of surfaces and ternary phase boundaries. Many such models were later made at the National Physical Laboratory under Rosenhain's direction when he was superintendent of the metallurgical department.

An alternative method of constructing these space models, which was tried by Rosenhain, was to make solid phase volumes from plaster of paris, these being fitted together so as to build up the complete equilibrium prism. He also prepared some models from celluloid, drawing on sheets of this material a number of vertical sections through the ternary prism. These were mounted at appropriate distances from each other, but the celluloid of those days was not sufficiently transparent to render the method satisfactory, and the clear plastic plate now available, recommended by Mr. Smith, would doubtless be more successful. (A. J. MURPHY, Chief Metallurgist, J. Stone & Co., Ltd., London)

Pressed Assemblies for Brazing

FURNACE BRAZING in controlled atmospheres is a most economical method of assembling parts, as many production men and metallurgists know. Frequently, though, the problem of assembling the units to be joined has been given insufficient attention, with the result that much useless preliminary riveting or spot welding is done, or else the furnace is overloaded with clamps and fixtures, thus cutting down its productive efficiency.

Usually a press fit is far to be preferred. It is possible to make the general statement that any two metals which can be kept in contact with each other while passing through the furnace, with the proper alloy applied, will come out brazed together. This is due to the fact that copper, which is the commonly used brazing alloy used for steels, when wet, will by surface tension or capillary pull be pulled into a clean joint where it has a chance to wet both members on the outside.

The penetrative power is really remarkable. Strength of brazed joint, however, falls off if the fit is too tight. Thus:

PRESSURE	PRESS FIT	MAX. SHEAR STRENGTH OF JOINT
800 to 100 lb.	0.0015 in.	32,000 psi.
300 to 400	0.002	34,000
Hand assembly	Loose	23,500

Thus we have found the strongest joint resulting from assemblies of 0.002-in. press fit. Another disadvantage of tighter fits is that it takes a longer furnacing time, to permit the copper to penetrate.

Standardized fits are of utmost importance when the amount of brazing material must be carefully controlled so it will not spread over the external surfaces — when, for example, it would interfere with bonderizing. (A. K. PHILLIPPI, Manufacturing Engineer, Westinghouse Electric & Mfg. Co.)

Chromium Plate to Minimize Decarburization

A PROBLEM confronting many small heat treating plants is the prevention of "soft skin" or decarburized surfaces in hardening tools of high speed steel, particularly the molybdenum types. If the tools are ground after hardening, thus removing the decarburized surface, no detrimental effects develop, but on tools such as form cutters that cannot be satisfactorily ground on significant surfaces, the problem becomes serious.

Fully equipped heat treating facilities minimize or eliminate decarburization through adequate control of furnace atmosphere or the use of salt baths. These are generally too expensive or involved for use in small plants, which rely on methods such as pack hardening or coating with borax. Maximum hardening temperature cannot be attained in pack hardening for fear of car-

burization and subsequent melting of the surface of the tool. The borax coating does not completely prevent decarburization, and if appreciable amounts come in contact with the furnace hearth a damaging slag results.

Chromium plating the tool before hardening is a superior method, proved by a year's use. The chromium plate used is approximately 0.0002 in. thick. (Excessively thick deposits should be avoided since they cause a corresponding "build-up" of refractory scale.) The plate is deposited from a standard hard chromium plating solution at 131° F. by plating for 12 min. at a current density of 1½ to 2 amp. per sq.in. This current density is on the low side of the range for a bright deposit.

Our high speed tool hardening furnace used for hardening the plated tools is equipped with a partial atmosphere control, which consists of the injection of a controllable mixture of natural gas and air into the working chamber. The products of combustion of this gas-air mixture become the furnace atmosphere, which is "controllable" over a range from a high gas-air to a low gas-air ratio. Water vapor is always present, however, and it acts as a strong decarburizing agent; its effect can only be eliminated by drying the atmosphere, and this requires somewhat expensive equipment. The thin layer of chromium effectively protects against decarburization by the water vapor present. The atmosphere is maintained at about 8% CO.

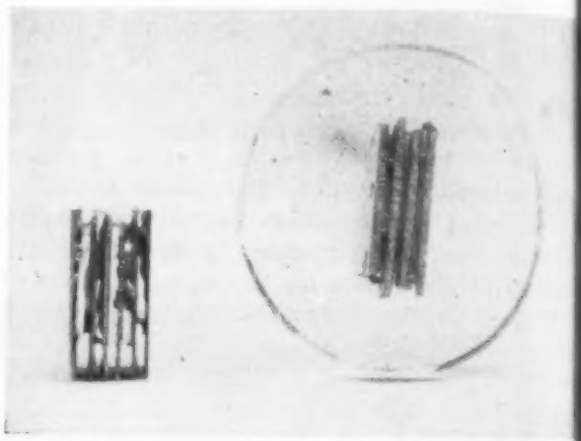
Normal soaking periods at the hardening temperature are recommended. Long soaking times at the hardening temperature will result in a decarburized surface despite the chromium plating, more particularly if the atmosphere is on the oxidizing side. The rate of decarburization, however, will be greatly reduced. (R. F. SCHAFFER, Metallurgist, Gardner-Denver Co.)

Mounting Small Sheet Specimens

VARIOUS methods are practiced for placing several sheet specimens in the same metallographic mount, such as bolting them together, binding them by wire, or by the use of special fixtures. But all of these methods are time consuming, it being not at all uncommon for one to spend a couple of hours on them. In fact, I personally have spent a whole afternoon on a mount using a fixture in which the top edges of the sheet specimens are clamped between small washers, strung along on a ⅛-in. screw!

Professor Sproule's scheme in September's *Metal Progress*, of pinching them between folds in lead sheet, is therefore welcome. I have found that metal adhesive is equally effective. The exact technique is as follows:

Spread a little of the liquid adhesive on the first two pieces, or the first piece and the first spacer, if spacers are to be used. (I have had success with "Cordo Metal Adhesive No. 1070" manufactured by Cordo Chemical Corp., Norwalk, Conn.) When the adhesive is in the tacky condition, which takes only a few seconds, press the two coated surfaces together until they stick. The spacer top-edge should be parallel to the specimen top-edge but offset from it. Lay the



At Left Is Stack of Six Sheet Specimens Cemented Together, Spacers Between; the Completed Mount Is of Four Spaced Sheet Specimens

cemented pieces flat and spread a thin coating of the adhesive over the uncoated face of the spacer and some on the second sheet specimen to be included in the mount. Wait a few seconds, then press the specimen onto the two already cemented. Continue cementing and building up until all are assembled. After the last specimen has been cemented, the stack is clamped in a screw clamp, such as used on rubber tubing, the object being to apply slight pressure while the adhesive is setting; otherwise, a strong bond which is necessary will not result.

The stack of specimens is ready for mounting after about 30 min. in the screw clamp. To speed the setting time, the stack in the clamp may be heated in an oven at about 150° F. for about 5 min. and then mounted.

It was found that the width of the spacers should be less than that of the specimens; otherwise, if the back edges of the spacers extend beyond those of the specimens, the mounting press forces the spacers downward, resulting in a mount with the polishing edges of the spacers and specimens even, thus losing the advantage of spacers. (S. J. BRODERICK, Materials Laboratory, Wright Field)

Working a Heat of Acid Electric Steel

(Notes for Operators)

By Conrad C. Wissmann
CF 3/C
Construction Battalion
U. S. Navy

Continuing his series of instructions for melters and furnace helpers, the author discusses in detail the cause of the "boil", how it is started and stopped, the desirable amount of carbon at the end of the boil (as related to the specification for the finished casting) the undesirable "silicon boil", the danger of over-oxidized or over-reduced baths and how to prevent their occurrences.

SOME HINTS on the proper way to charge an electric furnace in order to melt quickly with minimum damage and scour on hearth, walls and roof were given in the first chapter of this series on steel making in the acid electric furnace (*Metal Progress*, October 1944, page 723).

We will now assume that the charge is all melted or nearly all melted, so it is time to start working the heat. A little iron ore and silica sand should be spread over the bath at this time. If the charge has been high in return foundry scrap very little "slag" (silica and ore) will have to be added, since the oxidation of the silicon and manganese from the scrap will form almost enough slag. Also some of the iron on melting down will have oxidized, forming iron oxide (FeO) which will also contribute to the slag. However, the tendency is for this melt-down slag to be too high in basic oxide, so a little neutralizing acid (silica sand) should be added to every heat so that there is a layer covering the metal at least ⅛ in. thick.

It may be difficult to melt with a layer as thin as this, but it is never a good idea to have more slag on the metal than a very minimum at any stage of the heat since it will only slow down the time necessary to deoxidize the steel. If "slag", as the furnace men frequently call silica sand, is not added, the steel will slag itself by taking silica from the hearth.

A sample of slag taken from the furnace on the melt down should be a glass of black color, indicating a high iron oxide (FeO) content, a necessary condition if a boil is to be expected later in the heat. (At the same time a sample of the metal should be taken from the furnace to determine the carbon content. The carbon content after melt down should be higher than what is desired in the finished metal when it is killed by alloys of silicon and manganese near the end of the heat. This excess carbon will be removed by the "boil".) If a slag test taken from the furnace is not black in color but a brown or pea green, it indicates insufficient FeO, so ore should be added shovel by shovel-full until a black slag results. If the charge is high in return scrap the ore should be added before it is all melted; this ore will enter the bath as FeO, trading its oxygen with surplus silicon and manganese in the melting metal, thus forming silicon dioxide (SiO_2) and manganese oxide (MnO) respectively. Due to their lighter specific gravity, they will rise out of the metal, and due to their affinity — one being an "acid" and the other a "base"—they join to form slag. The chemical reactions are written

$$2\,FeO + Si \rightarrow SiO_2 + 2\,Fe$$
$$FeO + Mn \rightarrow MnO + Fe$$

Silicon and manganese must be oxidized before the carbon in the molten steel can combine with more oxygen from the ore to form the "boil", so that it is best practice to oxidize these two alloys out of the steel while the bath is still rather cold. (High heat favors the combination of carbon and oxygen.)

The color of the slag is also an indication of the amount of oxygen dissolved in the steel, since the oxygen or FeO in the steel is proportional to the amount of FeO in the slag. A pea green slag, which is a slag high in SiO_2 and low in FeO, can only exist on a bath of molten metal which has little oxygen dissolved in it, because if there were much oxide in the metal a considerable amount would promptly go into the slag to re-establish the proportional balance — or "establish equilibrium" between oxygen in slag and metal, as the scientists would say; they have found by precise laboratory experiment what this ratio is between the oxygen content of simple slags and the oxygen content of the metal at various furnace temperatures. Therefore, if ore is added to the slag the metal will absorb the excess FeO from the slag until the equilibrium ratio is reached. The reverse is also true; if something is added to the metal which absorbs the oxygen already dissolved in it, more oxygen will go into the metal from the slag until equilibrium has been re-established.

Therefore, it is well to repeat that the color of the slag is always an indication of the degree of oxidization of the metal, that is, its FeO or oxygen content. Also remember that after the melt-down, the steel should be in an oxidized condition. This is necessary if the steel is to boil later in the heat. Boiling is necessary for clean high quality steel manufacture. Finally the carbon should be higher than that necessary to finish the heat if a hard boil is to be attained.

Nature of the Boil

Assuming now that the metal is under a black or oxidizing slag and its carbon content is high enough, the next thing necessary is to pick up temperature until the steel is hot enough to boil. This "boil" is a reaction between the carbon and oxygen dissolved in the steel. They combine when a certain temperature has been reached to form carbon monoxide, a gas. The chemical reaction is

$$C + O = CO \text{ (a gas)}$$

This gas bubbling out of the steel will give the bath the appearance of boiling. Enough ore and enough carbon should have been in the bath, either naturally or by additions, to maintain this boil for at least 10 min. It is claimed by some competent melters that the longer the boil is maintained, the better the quality of the steel will be. However, the present author has not found this to be true. In the testing of heats that were boiled different lengths of time, the results never showed that a boil longer than 10 min had in any way improved the physical properties of the resulting castings. Still, there is no doubt but that steel which has been put through this minimum time in boiling will have very much better quality than steel which has not been boiled. Consequently this stage of the heat is probably the most important.

As boiling proceeds, the carbon gradually leaves the metal, taking with it the oxygen which was added for that purpose. The progress of this reaction can be noticed at any time by observing the color of a slag pancake (which, as emphasized above, will indicate the oxygen content of the steel). To determine the carbon content, a sample of metal is taken from the furnace and poured into an iron mold to make a bar ¾ to 1 in. square by 6 in. long. This chilled sample is then cooled by dipping it in and out of water. When cold it is broken in two by a sharp blow with a sledge hammer. The appearance of the fracture to a skilled eye is an indication of the carbon. The lower the carbon, the coarser the grain structure, and the higher the carbon the finer the grain structure. A good deal of experience, comparing the eye estimation with laboratory analyses of the same bar, is necessary before these fractures can be read accurately. Most shops today make use of a "Carbometer", which determines carbon fast and accurately, and this machine is a great improvement over the estimation by fracture.

The intensity of the boil will gradually diminish as the oxygen in the metal is reduced. The slag, at the same time, is continually changing in color. When it has reached the pea green stage and has thickened up enough so that a spoon which is flipped around in it picks up small lumps of slag, the steel is in as deoxidized a condition as is possible to achieve by the carbon reaction. It is then ready, after the alloys have been added, to be tapped — providing the temperature is right. But first a carbon test should be taken and the carbon adjusted to the content desired. Silicon and manganese should then be added as ferro-alloys and the heat tapped soon after their addition, melting and complete diffusion in the bath. The only thing to be gained by holding the steel in the furnace any longer than is necessary for the ferrosilicon and ferromanganese to have become dissolved is to allow

the reaction products time to coalesce, float up and join the slag. Part of these two alloys absorb the minor amount of oxygen which is left in the metal after the boil, forming oxides which either float out or become inclusions in the steel. The chemical reactions are very simple, and depend on the greater "affinity" of silicon and manganese for oxygen than iron has:

$$Si + 2\,FeO = SiO_2 + 2\,Fe$$
$$Mn + FeO = MnO + Fe$$

Completely clean steel, free from oxide inclusions, even microscopic ones, is impossible to produce commercially, for this reason: As the FeO content of the metal has been lowered by the deoxidizing ferro-alloys, the FeO in the slag will start going down into the metal to re-establish equilibrium. This oxygen which enters the metal will combine with the metallic atoms of silicon and manganese which have just been added to the steel, and thus form more inclusions in the steel. Since inclusions have a detrimental effect on the physical properties, the heat should be tapped as soon as possible after these deoxidizing agents have been added and their main reaction products eliminated. The reversal of oxygen into killed steel is fortunately *very* slow, as the heat is now lying quiet, and the only path for interchange from the slag above is at the top surface of the steel. The very thin layer of metal actually in contact with the slag is such a tiny per cent of the whole body of metal in the bath that the amount of reabsorbed oxygen (and inclusions formed therefrom) is quite low — unless the killed steel is held in the furnace for a wholly unusual time.

Therefore the best rule is, pour the heat within a few minutes after the ferro-alloys have thoroughly dissolved; a little time is necessary for the inclusions to rise; too much time merely holds up a furnace for no good reason.

The above is the log of an ordinary heat. Let us discuss what happens in heats that melt down with the wrong carbon content — first, one with very little carbon, say, ten points (0.10%) or less. This is usually caused by the scrap having absorbed an excess of FeO on the meltdown. Such a heat will offer a great deal of difficulty in deoxidizing — that is, in getting the metal in the condition that is necessary before it can be tapped.

It is very easy to tell when a heat is melting down very low in carbon. The metal in the furnace will lie quietly. It will be possible to see clear across the furnace, since the space above the metal is relatively free from smoke and flames. A sample of the steel when poured into a metal mold will "gas" very badly, and will leave only a shell in the mold, a sample not thick enough to even give a fracture reading for the carbon.

Carbon should be added to the steel as quickly as possible, since the bath in this condition is very badly over-oxidized. The best method is to "carbon up" with the electrodes — that is, shut the power off and run the electrodes down into the bath. A furious boil will take place in the metal immediately around the electrodes, which will help free the steel of the excess oxygen. It boils out as CO, carbon monoxide gas. In very bad cases the electrodes may be run clear down to the bottom and left there from 20 to 30 sec., then lifted out without the metal having increased any in carbon, since all of the carbon which was dissolved off the electrodes will have boiled out as fast as it went in. However, this is a very speedy method of helping to deoxidize the steel.

It sometimes happens, when the carbon content is raised by adding pig iron, that the metal will still lie quietly in the furnace and will not boil even though hot enough. The boil can then be started if a heavy chunk of scrap, say a piece weighing 20 lb., is thrown into the furnace. However, this is risky. Sometimes the boil will start with such intensity that metal will be kicked out of the doors.

Usually the heat will have to be carboned-up several times until enough has been added to boil out the excess oxygen. In such a heat, the bath should not be allowed to get too hot before the slag has started to "shape up" — that is, change from a dark color to a lighter color. Since the heat will, in all probability, have to be held in the furnace longer than is usual, there is danger of pulling bottom. (In any heat there is always danger of pulling bottom when the steel is hot.) The steel should be heated by extra power to a temperature where it will boil hard. Then the power should be cut back to a lower tap on the transformer until the slag has begun to shape up.

If, on the other hand, a heat should melt down too high in carbon, additional ore will have to be added over what is usually used. Here, as before, the bath should be heated until a hard boil develops, then the power cut back until the carbon is reduced sufficiently. If, in any heat,

an excess of ore or of carbon is added, a corresponding amount of the other should be added to neutralize the error.

Towards the last of a heat, when the metal is hot, the slag will sometimes have "shaped up too much". It will be very thick and gummy. A second boil, different from and weaker than the first carbon-oxygen boil, will develop. It is called a "silicon boil", and comes about in this manner: As the temperature of the steel increases, the affinity of its carbon for oxygen increases — in fact it approaches the affinity of silicon for oxygen. Then the carbon begins to react with the free silica* in the slag according to the following reaction:

$$2\,C + SiO_2 = 2\,CO + Si$$

The carbon monoxide passes off as gas bubbles and the silicon enters the metal. This silicon will deoxidize the steel by reacting immediately with residual oxygen. This will be noticed if a test is taken from the furnace; it will gas very little, if any, and will dish down in the center of the mold — an indication of a deoxidized condition. The test sample, if broken, will also show a woody fracture. It is impossible to judge the carbon content of the metal from such a fracture.

This is, generally speaking, an undesirable condition. If crushed lime rock is available, a shovel-full of it spread into the furnace will stop this silica reduction, for the lime (calcium oxide) will combine with the free silica in the slag and will hold it as calcium silicate. If lime rock is not available, a little ore added to the furnace will also stop the reduction, the iron oxide fixing the free silica as iron silicate.

Steel in this condition has a greater shrinkage than steel which is killed by ferrosilicon, as will be noticed by the degree to which the metal will shrink down in the heads of castings. It also seems to be less fluid than the other metal, even if the pyrometer measures the same temperature. It is commonly referred to as "over-reduced steel", and is a hard metal to cast properly. As far as its physical properties go, the author has never found that it had any better or inferior properties than steel properly killed with ferrosilicon if the final analyses are equivalent.

Should this silicon reduction start, it should be stopped quickly as it is very hard to control. The metal can pick up extra silicon very rapidly. In 5 min., if the metal is very hot, it can pick up as much as 0.20% (20 points). Its start can be noted by dense white smoke coming out of the furnace around the doors and electrode ports. If the reduction should start when the heat is only a few minutes from being hot enough to tap, it should be stopped by lime rock; only a part of the ordinary ferrosilicon should be added so the finished metal will not be too high in silicon. If the heat is 10 min. or more from finish, enough ore should be added to the slag to keep the heat from going into the silicon reaction while it is picking up temperature. In the latter case the usual ferrosilicon addition should be made.

It has been claimed by some that steel made by reducing silicon from the slag is exceptionally sound and clean. However, as noted above, the author has never found that the physical properties or soundness of such steel is in any way superior to that steel which is deoxidized by normal ferrosilicon addition. Neither did it seem to be any cleaner when viewed under a microscope. Lastly any molding foreman will tell you that it is very hard to make sound castings from such steel, due to its decreased fluidity and greater shrinkage.

Developing a Standard Practice

Every furnace man should standardize his furnace practice as much as possible; that is, he should try to put into every heat (as nearly as possible) the same amount of return scrap, heavy pieces and small scrap so that each heat will melt down with the same residual silicon, manganese and FeO in the steel. Also he should try to melt down the same carbon content. If the scrap available is low in carbon, then pieces of broken electrode or pig iron should be added to the charge so that the carbon at melt-down is above the carbon which is necessary when he taps a heat. (Carbon chunks should be shoveled in first and the bottom scrap placed on top of them to insure that the carbon gets into the melt.)

If the returns — that is, scrap high in silicon and manganese — are high in the charge, it is good practice to shovel in some scale with the charge; this will oxidize out the excess silicon and manganese during the melt-down. Scale is better than ore to add with the charge since it aids in making contact and is readily absorbed by the metal. After the bath is melted, ore and not scale should be added to the furnace if more oxide is necessary to get a good boil. If scale is added a great deal of extra heat is gen-

*The true nature of electric furnace slags is still a matter which physical chemists are studying. For our purpose we can simplify the matter by regarding the melt down slag as a mixture of silicates, iron silicate (a chemical compound of two molecules of iron oxide FeO and one of silica SiO_2) and manganese silicate (MnO and SiO_2). Such a mixture of molten silicates can dissolve extra oxides; any extra silica beyond the requirements of the chemical compounds is known as "free silica".

erated in the furnace, as can be readily noticed by the flames pouring out of the door and around the electrode holes. This heat is hard on the roof and walls of the furnace. Ore is just as effective and eliminates this excessive heating.

At the start of the boil the melt should have a correct carbon content, usually 10 to 20 points higher than what is needed to finish the heat. The slag should also have a certain color. It is possible to get a boil even if the slag is a dirty brown and not a black. For some practices this is even preferable to a very black slag, in the event that the power input is high, the bath is

Fig. 4 — A Vigorous Boil, as Seen by a Movie Camera Through a Furnace Door

hot, and it will not take more than 10 min. from the time the boil starts to the time the heat is hot enough to tap. In such a heat if the slag is black before the boil, the power will only have to be reduced to give the heat time enough to "shape up" — that is, to be deoxidized. If the power input is low, a darker slag should be present at the start of the boil, since the boil should carry on for a longer period of time.

The ideal condition is for the boil to have boiled itself out when the heat is hot enough to tap. This will have to be discovered for every furnace, since the time from the start of the boil to the time when the metal is hot enough to pour will vary for different conditions. Two things should be kept in mind: The steel should be boiled for at least 10 min. and the slag, when the steel is tapped, should be a pea green color and have started to lump up. If too little ore has been added, or if the slag was not dark enough before the boil, there is danger of a silicon boil.

The carbon test and the slag test, taken from the furnace just before the boil, are the most important tests taken from the furnace at any time during the heat, since if the carbon content for that stage of the heat is right and the slag the right color for your particular furnace, the heat will practically make itself.

As has been stated many times before, if good steel is to be made, the heat must be boiled. The reasons will be discussed at length in later installments. Many melters believe that the best steel will result when the boil decreases the carbon to a definite content; however, there seems to be a great difference of opinion as to what the percentage should be. One shop will set one maximum figure and another shop will have another. The author does not believe that there is any definite figure that can be set. In one study of over 200 heats, the carbon content before and after the boil and the time were compared with the results of the physical testing of the metal, and there did not seem to be any correlation.

The results did seem to indicate that the steel should be kept boiling for at least 10 min. to secure the best physical properties.

However, there seems to be one qualification needed: There is good reason for not allowing the carbon content of the steel to go below 0.20% unless that figure is too high for the type of low carbon steel which is being made. The reason is that as the carbon content of the steel decreases, the per cent of FeO which the steel will hold in equilibrium with that amount of carbon, also increases. In other words, when the carbon is driven very low the steel picks up excessive amount of oxygen at the same time.

The condition of the slag *after* the boil is likewise very important. Here, also, every melter seems to have a different opinion as to just what the viscosity of the slag should be when the steel is tapped. However, practically all seem to agree that it should be pea green, which means that steel should not be tapped except under a slag which has very definitely reached a minimum content of iron oxide, manganese oxide and other basic oxides if any are present. It is to be remembered that the lighter the slag, the less basic oxide (FeO and MnO principally) the slag contains and the larger the percentage of acid oxide (SiO_2) and therefore the less FeO there will be in the metal. (Remember that there is always a ratio between the FeO content of the slag and the FeO content of the metal in equilibrium with the slag.) Likewise, the less FeO in the steel, the cleaner it will be — that is, the less inclusions it will have. For these reasons the FeO content of the slag after the boil should have reached the point where the slag will string down from the test spoon, or the slag remaining on the spoon should be in a slightly lumpy condition. (There is very accurate way of measuring the degree to which the slag has shaped up by a slag viscometer; it will be discussed in detail later.)

Tapping Temperatures

The temperature at which the steel is tapped from the furnace will vary, shop to shop, depending largely on the size of the castings poured and the means of handling the molten metal. If the metal is poured from a large ladle into hand shanks, it will have to be quite hot on tap (perhaps 3200° F. by optical pyrometer) since usually small castings are poured. However, if the metal is poured directly from a large ladle into the mold, the steel should be 150 to 200° F. colder when it is tapped from the furnace, otherwise there will be danger of the casting burning into the sand mold.

The temperature of the steel which is desired by your shop will have a great deal to do with your method of working the heat, because the hotter the steel, the greater the ability of carbon to combine with and remove oxygen from the bath. If your shop pours practically all small castings and therefore needs a very hot steel, little difficulty will be had shaping the slag up during the boil since the carbon, if the metal is hot, will react very readily with the oxygen in the steel and remove it as carbon monoxide gas. It is not uncommon for steel which is heated as hot as this to change from a black slag at the start of the boil to a pea green slag during 7 to 10 min. of boiling with a drop of from 0.10 to 0.20% (10 to 20 points) of carbon. Consequently, melters tapping a hot steel will have very little difficulty in shaping up the slags as long as there is sufficient carbon in the steel to carry out the reaction.

However, in shops that are pouring castings which range from 1000 lb. to several tons, the metal cannot be heated as hot. In such steel it would not be uncommon to take 20 to 30 min. to reduce carbon 10 to 20 points; furthermore, at the end of the boil there is always danger that the slag will not shape up — that is, the metal will not be in a deoxidized condition.

This is no reason why these shops should not also boil their steel. Obviously it would be foolhardy for them to melt down with a carbon content 10 to 20 points higher than the amount desired before the heat is tapped, as this would delay the furnace a great deal. The better practice would be to melt down several points high in carbon and add enough ore to keep the metal in a boiling condition for a minimum of 10 min. while the steel is picking up temperature to tap. Then, if an addition is made of silico-manganese (enough being added to raise the silicon content of the steel 12 points), this addition will stop the boil. The oxides unremoved from the metal by the carbon reaction will then form manganese silicate particles in the steel which are readily fluxed up into the slag, leaving the metal in a clean condition. The *time* between additions and tap depends somewhat on the temperature of the metal, and should be worked out to meet the conditions on the molding floor.

It has already been emphasized that the heat should be melted down with a carbon content high enough so that after 10 min. of boiling the carbon content will be only slightly *lower* than that specified for the finished castings. There is a very good reason for this other than to provide for a little carbon pick-up from the ferro-alloys used to block the heat. The reason can be seen very quickly from Fig. 5.

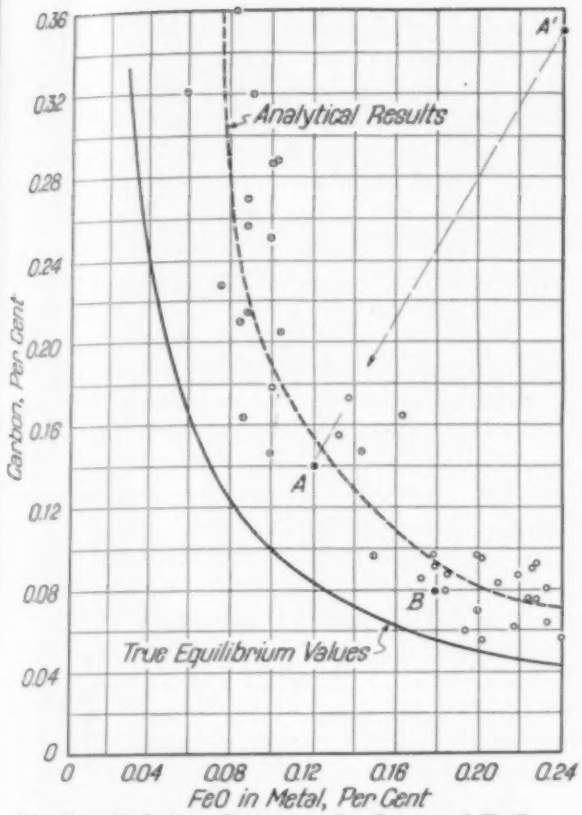


Fig. 5 — Relation Between Carbon and FeO in Metal of Heats Controlled for Low Oxygen Content (Temperature about 2900° F.)

This chart, taken from page 63 of Cooperative Bulletin No. 68 of the Metallurgical Advisory Board to Carnegie Institute of Technology, shows by heavy line the carbon content *which is in equilibrium* with the FeO content of the steel. Let it be remembered that when the steel is boiling in the furnace, the carbon and the FeO are not in equilibrium. Equilibrium is established only after considerable time and under favorable laboratory conditions. The FeO content of the steel in the furnace is always greater than that amount which would be in equilibrium with its content of carbon. For example, the heat that ended its boil at A, with 0.14% carbon and 0.12% FeO in the metal, started its boil with an analysis at A', somewhere around the top right corner of the diagram, say at 0.35% carbon and 0.24% FeO. The boil brought both the carbon and the oxygen down to a practical halt, even though the system still tries to get into equilibrium. However the reaction slows down toward the end, and time cannot be given; also it seems that oxygen is continually being fed into low carbon heats, from the atmosphere through the slag, faster than it can be removed by carbon alone. Consequently it really does no good to boil the carbon down too low, lower than necessary to finish the heat. Suppose, for example, the melter boiled a similar heat down to B; his carbon at 0.08% is too low for specification and his final FeO in the metal before the block is actually higher than in heat A, being 0.18%. If the metal is to have as little FeO as possible when blocked, the carbon should not be allowed to boil down to any lower a content of carbon than is necessary to meet the specification in the castings.

Avoid Over-Boiling

A good many melters will run their furnaces on high power until the metal is boiling hard, then the furnace will be put on the low power tap until the boil has worked itself out. This commonly boils the steel for a much longer time than is necessary, and also reduces the carbon too low, with the result that after the boil has worked itself out, the metal will still be high in FeO. It is very true that steel must be put through the boiling cycle. However, a great many shops overdo it. Let us emphasize again that boiling carbon down to around 0.10 to 0.12% is poor practice unless it is absolutely necessary to finish with the right amount of carbon in the steel. It is far better practice to control the ore additions so it will not take as long to remove the oxide.

In addition to being poor metallurgy, this extended boil is hard on the furnace. The heat is held in the furnace longer than is necessary. Boiling is hard on the silica roof, since metal is thrown up and washes hot silica from the brick dome. Therefore, add just enough ore so the boil continues the correct time, providing that time is 10 min. or more. If the furnace can be left on high power at all times it decreases the time necessary to make each heat, there is less damage to the roof and walls, and it also produces just as good steel.

It may seem to the reader that we have not been specific enough. For example, no mention is made of the amount of ore which is necessary to add to a heat or the number of points of carbon it is best to have in the steel before the boil starts. However, the reader should remember that definite figures do not suit every furnace. Every shop will have to work these out individually, since each shop has a furnace or furnaces of certain size, melting down charges with a different power input, and tapping the steel at temperatures to fit the molding floor. For example, in one shop it may take the furnace 10 min. after the boil has started to heat the steel hot enough so it can be tapped. At another shop the time might be 20 min. due to a lower power

input or a larger heat. Obviously, the second furnace will have to have more ore added to the charge and also more carbon in it at the start of the boil if the boil is to continue until the metal is hot enough to tap.

However, these variables can be readily worked out. It is only necessary to determine the amount of carbon which will be oxidized from the steel during the boiling cycle and have the right amount of ore in the bath and the carbon content high enough before the boil so that the boil will reduce the carbon content to a point slightly below that which is necessary to tap the steel. If the boiling cycle is longer, naturally a higher carbon will be desired at melt-down, before the boil. Also the hotter the steel is to be, the higher the carbon content before the boil, since the affinity of carbon for oxygen increases with temperature, causing this reaction to take place more rapidly the higher the temperature. This last variable is an important one.

Difficulties With Low Carbon Heats

There are two types of steel commonly made that can offer great difficulty to a melter, namely a heat low in carbon and one high in carbon. A low carbon heat will be discussed first, and by "low carbon" we mean steel which is to finish at 0.14% or less.

In making a low carbon heat of this kind there is one difficulty to be overcome. Such a heat will have so little carbon at the end that it cannot fulfill its role as a deoxidizer. If the carbon content has been reduced to say 0.10% the boil will stop or practically stop. However, as shown in Fig. 5, the metal is still high in FeO — that is, in an oxidized condition. If the steel is tapped while it is in this shape it will be full of inclusions and in all probability it will make porous castings.

There is also danger that the manganese content will be too low, by the fluxing out of the manganese as manganese oxide into the slag. (There is always danger of the manganese being lost from any heat if the steel is tapped when it is still in an oxidized state.) It is best practice in a heat of this nature to melt down to around 0.20 to 0.30% of carbon and add ore to the heat until the slag is black. The furnace is then allowed to pick up temperature so that the steel will boil hard. The current should then be cut back holding the steel at a constant temperature. When the slag has started to shape up, a carbon test should be taken. If the carbon is not low enough, a *small* addition of ore should then be made. This may have to be repeated several times until the carbon content has been reduced to the figure desired. If too much ore is added after the carbon has been reduced to a low figure, there will obviously be considerable FeO left in the steel. However, if very small additions are made, say 10 lb. or so at a time for a 1-ton heat, the carbon will gradually be reduced without getting the steel into an over-oxidized state. When the carbon is only one or two points above what is desired, the power may then be turned up; as the heat picks up temperature the last two points of carbon will be taken out and with it the excess ore. It is possible to make a heat of this nature and have the steel under a slag of a pea green color at the end. Naturally one should use low carbon ferromanganese and other additions to such low carbon heats.

Some melters have the mistaken idea that the best way to make a low carbon heat is to start with low carbon scrap. Such a charge will pick up oxides during the melt-down, and since it does not have sufficient carbon in it to start a vigorous boil, these oxides remain in the steel and such a heat is almost impossible to shape up. It only gives a steel which is over-oxidized and full of inclusions.

It is also very hard for a melter to hit the specification for a high carbon steel if his only method of determining the carbon in the heat is to judge it from a fracture test. Since it is almost impossible to judge carbon from a fracture test when it is over 0.40%, best results will be obtained if the melter will follow the same procedure as for an ordinary heat of say 0.20% carbon — that is, melt-down, put the steel through the boiling cycle, after the boil take a carbon test, judge the carbon from the fracture, and then add enough pig iron to raise the carbon content to the amount desired. Whether this pig iron should be added to the bath after the deoxidizers or before the deoxidizers is a matter on which opinion differs. The author prefers to put the recarburizer in at the very last, and then hold the heat for an extra three or four minutes at least to insure that everything has melted and been assimilated.

If an attempt is made by the melter to melt down to a very high carbon content and hold it there by stopping the boil by a ferrosilicon addition, the heat will almost certainly go into a silica reduction while it is picking up temperature. It is also possible for some of the carbon to be lost. If the shop has a carbometer, the heat can be melted down high in carbon; *after the boil has stopped* the carbon is determined accurately in a couple of minutes by this machine. The heat can then be carboned up to the amount desired and the usual final additions made.

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Personals

LEWIS S. BERGEN, national trustee, has resigned as associate director of metallurgy and research for Crucible Steel Co. of America, to form Bergen Precision Castings, Inc., Pleasantville, N. Y., of which he is president.

LLOYD F. JOHNSON has been elected vice-president of Illinois Zinc Co., Chicago.

E. A. CARLIER, formerly plant engineer of the Tank Division of Federal Machine & Welder Co., is now general superintendent of the U. S. Manufacturing Corp., Decatur, Ill.

V. W. VAURIO, formerly in the research laboratory of Tennessee Coal, Iron and Railroad Co., Birmingham, Ala., is now with the research laboratory of Carnegie-Illinois Steel Corp. in Pittsburgh as development engineer, tin plate service.

GEORGE N. STUART, JR., formerl assistant to the works manager the Western Cartridge Co., E Alton plant, has been appointe general superintendent of X-Ra Inc., Detroit. MAYNARD B. EVAN past national president of the Ame ican Industrial Radium and X-R Society, is secretary-treasurer an chief engineer; C. L. DARLING field service engineer; and WILLA JOHNSON, formerly of Buhl M Co., is production engineer X-Ray, Inc.

J. J. ZIMMERMAN, formerly Atlanta, Ga., is now connected wi Reynolds Metals Co., Plant 1 Louisville, Ky., as chief tool eng neer.

Transferred by Glenn L. Marti Co.: BYRON F. CAMPBELL, fro chief of laboratories, Omaha, Neb to design engineer in Baltimor Md.

RALPH F. JUMET, formerl metallurgical engineer in the Me chant Marine Division of Westin house Electric and Mfg. Co., Leste Pa., is now tool application an research metallurgist with th Parker Appliance Co., Cleveland.

S. H. GRAF, head of the d partment of mechanical enginee ing, Oregon State College, has al been advanced to director of th Engineering Experiment Station.

L. F. WORSHAM, formerl plant metallurgist for the Capit Foundry Corp., has resigned to ac cept the position of heat tre superintendent with the Kaise Industries' new shell plant at Den ver, Colo.

PHILIP R. MARVIN has bee appointed director of research an development for the Milwaukee Ga Specialty Co., Milwaukee, Wis.

Transferred by Chevrolet Moto Division, General Motors Corp. JOHN J. KARY from the Detroi plant to the Chevrolet-Shell Divi sion in St. Louis as metallurgist.

H. A. SCHWARTZ, manager o research, National Malleable an Steel Castings Co., Cleveland, ha been selected to deliver the thir American Foundrymen's Associa tion Foundation Lecture at the 194 Foundry Congress next spring, o "Solidification of Cast Metals".

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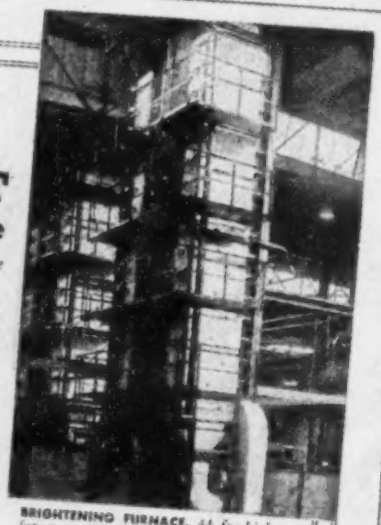

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Personals

I. C. SLEIGHT, formerly assi ant project engineer, Wright Ae nautical Corp., Paterson, N. J., now development engineer at P. Mallory & Co. in the bearing di sion, Indianapolis, Ind.

EDGAR ELLIS FLETCHER is no working at Battelle Memorial Ins tute, Columbus, Ohio, as a resear engineer in metallurgy.

HAROLD MOORE has retired director of the British Non-Ferro Metals Research Association, Lo don.

Promoted by Curtiss-Wrig Corp.: RALPH A. FUHRER, fro general superintendent of planni and tooling to factory manager the Columbus, Ohio, plant.

Promotions by Minneapol Honeywell Regulator Co.: DAVE CHOATE, from the Milwauk branch of Brown Instrument Co. industrial manager at Atlanta, G W. S. ROBARDS, transferred fro St. Louis to industrial sales en neer of the Milwaukee branch, su ceeding Mr. Choate.

R. H. MUSSER, formerly in t Chicago office of Heppenstall C has been appointed assistant ge eral manager of sales in Pittsburg

DANIEL W. TALBOTT, former plant superintendent of the Symin ton Gould Corp., Rochester, N. Y has been appointed general ma ager for the Cooper Alloy Foundr Co. of Hillside, N. J.

J. E. WHITE, project manag in charge of construction, procur ment and equipment for Krop Forge Aviation Co., has been a pointed sales engineering represe tative of the Kropp Forge Co. f the northern part of Illinois.

L. E. PHELPS has been a pointed direct factory represent tive for Michigan Tool Co. wi offices in Minneapolis.

ROBERT BEERS, for the pa two years with the War Producti Board in Washington, has joine the staff of sales engineers attache to the New York office of the Fo boro Co.

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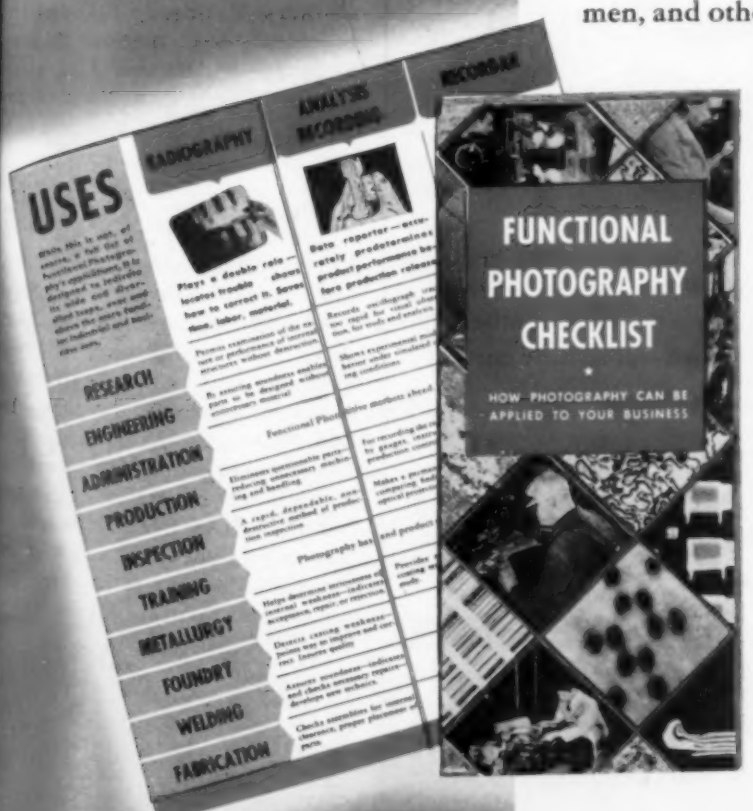

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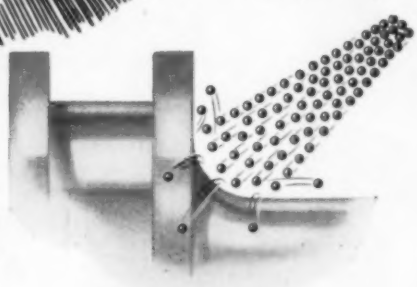

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M. E. GREENHOW, former plant manager and sales manag of Berg Metals Co., Los Angeles, h been elected vice-president a general manager of Olds Alloys C Los Angeles.

PAUL JAMES has been a pointed district manager of t Syracuse office of the Lincoln Ele tric Co.

Field engineers appointed Sterling Alloys, Inc.: JOHN SO NENFELD, for Missouri, weste Iowa, southern Illinois, Kansas a Nebraska; A. C. WOOLLEY, for Or gon and Washington; G. DELL for Kentucky and southern Indian

Officers elected by the Meeha ite Research Institute of Americ Inc., New Rochelle, N. Y.: OLIV SMALLEY, Meehanite Metal Corp president; H. B. HANLEY, Americ Laundry Machinery Co., first vic president; A. C. DENISON, Fulto Foundry & Machine Co., secon vice-president; C. S. NICHOLS, Me hanite Metal Corp., secretary-trea urer.

Appointments by Allegheny Ludlum Steel Corp.: GORDON BUTLER, to metallurgical engine and associate director of researc Tool and Die Steel Division; GU THER MOHLING, to metallurgic engineer and associate director research, High Temperature All and Valve Steel Division; R. LINCOLN, to metallurgical engine and associate director of researc Stainless Steel Division; GEORGE KIEFER, to chemical engineer a associate director of research, Co rosion and Coatings Division.

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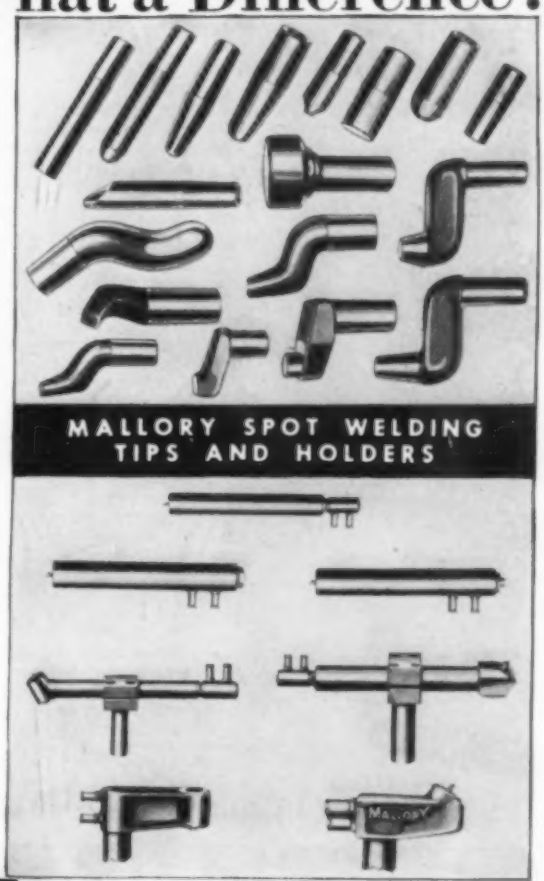

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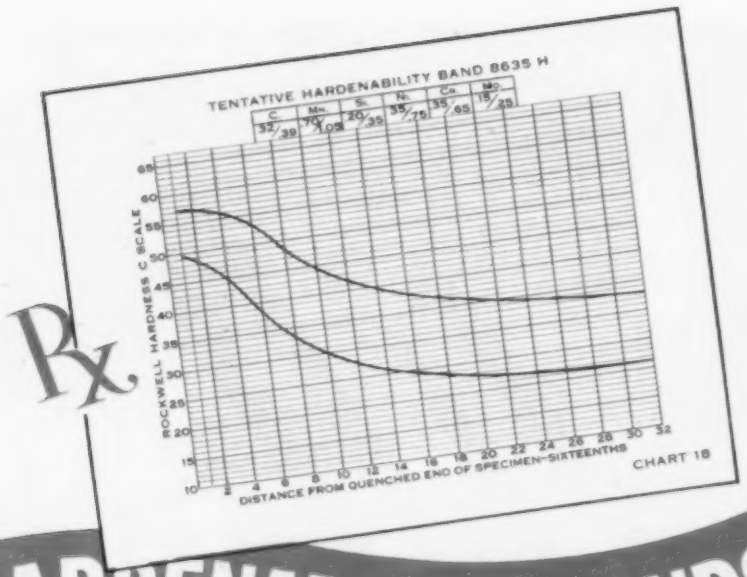


Rx

HARDENABILITY BANDS *are here!*

Are you prepared to take advantage of them . . . for improving your product?

THE A.I.S.I. has recently approved 37 standard steels that can be purchased on a basis of precisely prescribed maximum and minimum limits of hardenability. Other standard steels, being investigated on the same basis of their capacity to harden both in degree and in depth during heat treatment, will likely be added to the list.

While the use of a hardenability standard is a big step forward in predetermining steel characteristics and response to heat treatment, it should by no means be considered a magic key to steel performance.

In other words, even though you buy steel to hardenability bands, that is no assurance that your heat treating equipment or methods will produce optimum results. If your heat treating practice is faulty or your equipment is inadequate you simply can't get out of the steel what the steel maker has put into it. In spite of the superior uniformity assured by Hardenability Band standards, you'll still have warpage, quench cracks, soft spots, poor machinability and higher costs than necessary.

Here at Tate-Jones we offer you thorough and practical knowledge not only of conventional heat-treating but of the most advanced heat-treating methods—Austempering, Martempering and Purnellizing. We can guide you in the application of the proper procedure indicated for your particular needs—and we can furnish the most efficient heat-treating and tempering equipment needed to give you the results desired.

Our technical staff of metallurgists, combustion engineers and furnace designers is prepared to work with you on any problems involving heat treatment. Their expert advice is based on 46 years experience building quality industrial furnaces and heat-treating equipment.

For better results FURNACE ENGINEERS *in heat treating*

TATE-JONES

& CO. INC. • LEETSDALE (*Pittsburgh District*) PA.

Rotating Hearth • Car Bottom • Pusher • Conveyor • Roll Down • Horizontal and Vertical Pit • Circular and Rectangular Pot Furnaces • Also • Gas • Oil and Combination Burners

Personals

J. M. STAPLETON, former superintendent of blast furnaces for Geneva Steel Co., Geneva, Utah, has been promoted to assistant division superintendent of blast furnaces at South Works of Carnegie-Illinois Steel Corp.

New officers recently installed by the American Welding Society: President—A. C. WEIGEL, vice-president, Combustion Engineering Co., Inc.; first vice-president—ISAAC HARTER, vice-president, the Babcock & Wilcox Co.; second vice-president—W. F. HESS, assistant professor of metallurgical engineering, Rensselaer Polytechnic Institute; treasurer—O. B. J. FRASER, director of technical service on mill products, International Nickel Co.; secretary—M. M. KELLY.

WENDELL F. HESS, assistant professor of metallurgical engineering, Rensselaer Polytechnical Institute, and Lt. D. C. HERRSCHAFT, U. S. Army, have been awarded the Lincoln Medal of the American Welding Society for their paper on "Spot Welding of S.A.E. 1020, 1035 and 1045 Steels in the 0.40 Thickness".

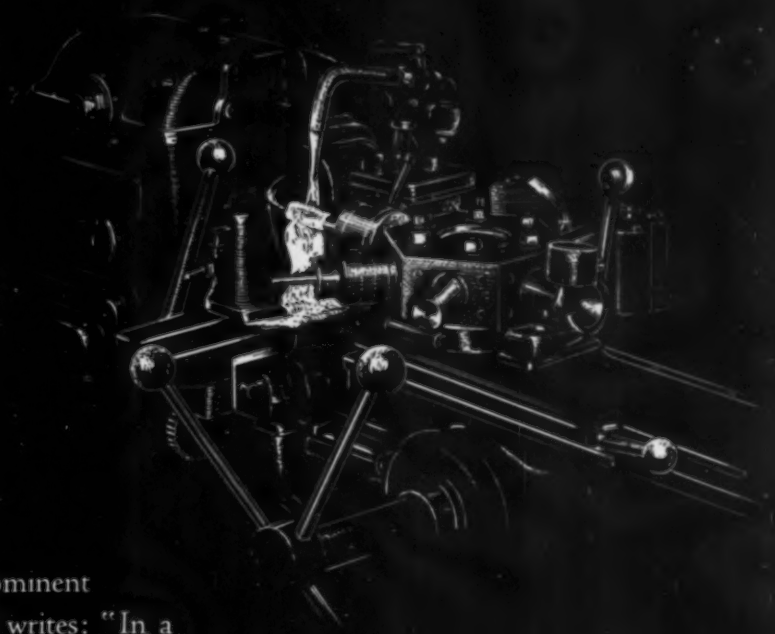
F. T. LLEWELLYN, retired, former director of research for the United States Steel Corp., has been awarded the Samuel Wylie Miller Memorial Medal and Certificate of the American Welding Society for his contributions to the structural welding field.

GEORGE S. KENDIG has been transferred from the Eastern Aircraft Division of General Motors Corp., Tarrytown, N. Y., to the Detroit Transmission Division as heat treat supervisor.

PAUL G. BROWN, formerly metallurgist with the Aluminum Co. of America at Massena, N. Y., is now metallurgist at Winters & Crampton Corp., Grand Rapids, Mich.

JAMES N. NUTT, JR. has left the metallurgical laboratories of Wright Aeronautical Corp., Cincinnati, Ohio, and has been commissioned an ensign in the U.S.N.R., assigned to the Bureau of Ordnance.

EXAMPLE OF *Service*:



In a recent letter, a prominent industrial manufacturer writes: "In a turret lathe, which usually required a change of tools after every sixth piece, your Chillo Cutting Oil has increased tool life more than 300% and improved finish." For another "Example of Service" write for your *free* copy of METAL CUTTING FLUIDS—26 pages of helpful information. Address: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

More and more, it's service that counts...

and *Cities Service* means good service!

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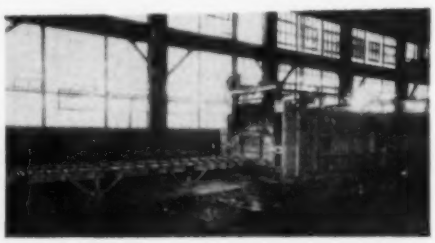
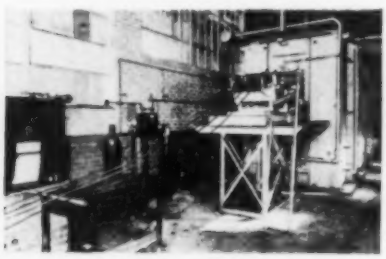
Rockwell contributions to "heat treating" in wire mill production have long been outstanding. Here are but a few of many successful installations that meet exact requirements of heating uniformity at minimum cost.

Let Rockwell furnace engineers cooperate with you in improving your heat processing practice. Write for bulletins.

Gas fired, cradle type roller batch furnaces for annealing coils of rod stock.

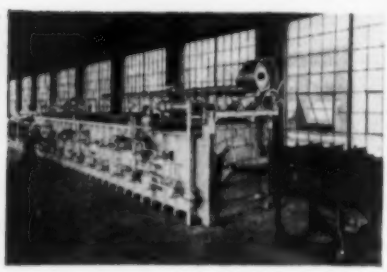


Cover type, batch furnace for bright annealing coils of strip steel.

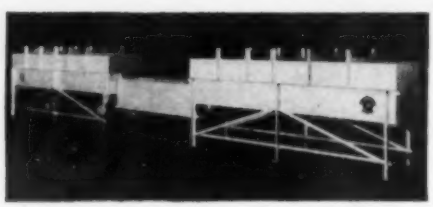


Oil fired, continuous, pull-through furnace for bright annealing high carbon steel strip.

Continuous pull-through furnaces for hardening and tempering steel strip.



Gas fired, continuous catenary type furnace for annealing stainless steel strand.



Electrically heated furnaces for clean hardening and tempering small gauge wire.

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ROCKWELL SINCE 1888 BUILT
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Personals

OLAF LORENTZSON, formerly foreman of heat treating at Reed Button Hole Machine Co., Boston, is now foreman of the forge and heat treating departments at Saco-Lowell Shops, Biddeford, Me.

R. W. BOLZ is now assistant engineer, general engineering department, National Carbon Co., Cleveland, Ohio.

WILLIAM J. BARNETT is now employed as a metallurgist in the research laboratory of American Steel Foundries, Indiana Harbor Plant, East Chicago, Ind.

T. O. DORMSJO is now with A. Johnson & Co., New York, representing Avesta Steel Works of Sweden.

FRED L. WEAVER has established his own business as foundry consultant, known as the Weaver Materiel Service, in Buffalo.

H. H. BOWERS, formerly with the Studebaker Corp., is now metallurgist and heat treating engineer in charge of the laboratory of the Boyar-Schultz Corp., Chicago.

B. FRANKLIN GRANT has left Kalamazoo Steel Process Co. and is now research engineer with the Crane Co. of Chicago.

CHARLES H. JUNGE, formerly metallurgist at Armour Research Foundation, Chicago, is now metallurgist at Cleveland Graphite Bronze Co., Cleveland.

HENRY J. ANTOSZ is now metallurgist at American Locomotive Co., Schenectady branch.

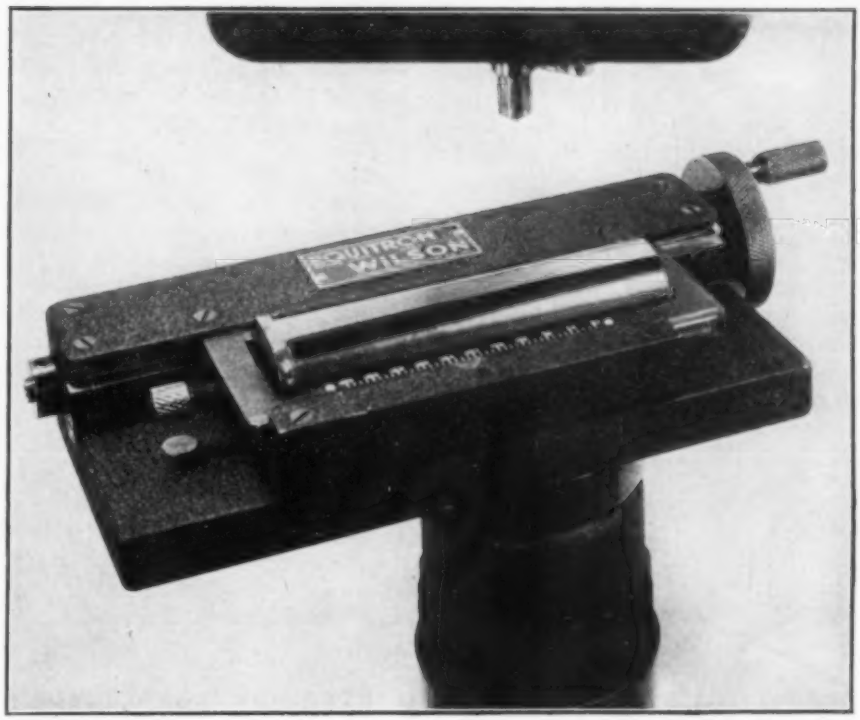
HARRY J. WURSTER, formerly experimental metallurgist at General Motors Corp., is now a manufacturing research engineer at Westinghouse Electric and Manufacturing Co.

JOHN B. RAGSDALE, on loan from Union Twist Drill Co. for the past 2½ years to AiResearch Mfg. Co. of Ariz. as plant superintendent, is now back in his former position as Pacific Coast factory representative for Union Twist Drill in Whittier, Calif.

EQUITRON

For Use With the

"ROCKWELL" HARDNESS TESTER



ixture for Supporting and Positioning Samples in "ROCKWELL" Testing for Hardenability.

he "EQUITRON" fixture is recommended for properly pporting the preferred specimen for the end quench st for hardenability of steel (generally referred to as e Jominy End Quench Test). This fixture is de-gned to properly support the specimen and also to ovide means for accurately positioning the sample r each successive "ROCKWELL" hardness test at 16" intervals.

he fixture is quickly and easily clamped securely to e elevating screw by means of a nut, which has oven decidedly preferable to reliance upon a stalk tting into the hole in top of the elevating screw of the ster. Ground surfaces are provided to support the derneath surface of the specimen. The specimen is us supported so that it does not rock or tip as the sts are made, notwithstanding the required moving of e specimen.

ccurate spacing of the indentation is accomplished by wheel and handle located at one end of the fixture. One revolution of the wheel provides a motion of the specimen of 1/16 of an inch. A ball click indexing mechanism indicates each 1/16" spacing, so one need pay little attention to the scale markings. The specimen is securely held in positive indexed position by spring pressure. This jig permits tests to be made up to 2½ inches from the quenched end of the specimen, and a scale is provided to indicate the positions at which the test is being made and to facilitate tests at greater intervals than 1/16" if it is desired.

The screw for moving the specimen operates in oil-less bearings. This fixture can be used on all "ROCK-WELL" Hardness Testers of 8" vertical capacity (size 3), or taller.

No attempt is made here to discuss the purposes and technique of carrying out end quench tests, as those are given at length in recommendations published by several technical societies.

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Personals

ROBERT S. MILES is now employed by Tubular Alloy Steel Corp., Gary, Ind., as supervisor of cold operations, industrial engineering department.

JAMES A. QUAID, formerly sales engineer, Allegheny Ludlum Steel Corp., Philadelphia, has been appointed Philadelphia district manager of the Pressed Steel Co.

JOHN R. REYNOLDS, formerly foreman of Symington-Gould's Rochester plant, has become melting foreman for General Metals Corp., Oakland, Calif.

MAX J. SCHARF is now employed by the General Petroleum Corp. in the production research laboratory, Los Angeles.

EMIL E. LEONARD is now senior tool liaison engineer with Goodyear Aircraft at Litchfield, Ariz.

CLYDE E. HOLMES, former in the engineering department Talon, Inc., is now with Cher Rivet Co. as project engineer.

Transferred by Aluminum C of America: ROBERT T. TEETER from the engineering staff of Tren wood Works to the patent divisio Aluminum Research Laboratorie New Kensington, Pa.

SUMNER E. PERKINS is no chief engineer, Richmond plan Rheem Mfg. Co., Richmond, Cali

A. W. PINGEL, formerly a sistant chief, division of armamen Curtiss-Wright Research Labor tory, is now assistant sales manag of Magnesium-Aluminum Divisi products, Revere Copper & Bras Inc., Rome, N. Y.

Transferred to Los Angele FRANK W. WELLS, made gener manager of manufacturing of t Sawyer Electrical Mfg. Co., a su sidiary of A. O. Smith Corp.

LOUIS KRISTOFF has tra ferred from Cleveland to Sprin field, Mass., as foundry metallurg for Reynolds Metals Co.

A. WARD JENKS has join Crucible Steel Co. of America sales manager, Forge Blanks Di sion, with headquarters in Detro

JOHN J. COUCH, formerly vi president, G. S. Rogers & C Chicago, has been elected preside Other promotions include E. MILFORD, elected vice-presiden DAVID H. HENRY, vice-president a secretary; and ROYCE R. BAK treasurer.

A. W. NELSON has been a pointed district sales manager the Indianapolis office of Allegh Ludlum Steel Corp. R. C. PRES has been transferred from t Chicago district to take Mr. Nelso former position as district rep sentative in Minneapolis.

CDR. R. H. LAMBERT has turned from sea duty in the Paci and is now inspector for materi in the Naval Gun Factory, Washi ton, D. C.

MILDRED BEAR is now c nected with the Kellogg Swit board & Supply Co., Chicago, a metallurgical assistant.

THE PIONEER OF HIGH SPEED TOOL STEELS

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NOVO SUPERIOR *is admirably suited for:*

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Circular Form Tools and all other metal cutting tools requiring superior quality.

Wherever fine tool steel is demanded you'll find NOVO SUPERIOR. Accepted from the very first as the standard, it has consistently held its foremost position throughout the machine world.

It offers unusual resistance to abrasion and holds a keen edge through long tool life.

Try NOVO SUPERIOR for your better tool needs. A year's run will demonstrate longer tool life, elimination of cracking during hardening and substantially lowered tool overhead.

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Many of war's implements owe their superior properties to the technical advances made by Induction Heating in improving and speeding up the brazing, annealing, hardening, melting and forging of ferrous and non-ferrous metals.

One of the most important applications of Induction Heating is the selective surface hardening of steel sections. This method produces parts that are uniform in structure and hardness without causing decarburization or affecting the portion so treated; as for example the mine sweeper cable cutter, illustrated above.

Thermonic generators and production systems, by the addition of time-saving and cost-saving advantages promise significant product improvements for the *plowshares* of tomorrow; for the innumerable types of such cutting tools as shears, knives, saws, chisels, cleavers, pliers, lawn mowers, etc.

So that you may be fully prepared to meet the needs of your industry in the post-war's markets, our laboratory and engineering facilities invite the opportunity to work with you—on both problems and plans.

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WHAT'S NEW

IN MANUFACTURERS' LITERATURE

METAL WORKING • FABRICATION

Cutting fluids for better machining describes the new 6-page handbook just published by D. A. Stuart Oil Co. It contains extensive data on steels, machinability, hardness, tools, speeds and feeds, and allied subjects, as well as on selection and use of cutting and grinding fluids. Bulletin 618.

Powdered metal presses. Kux Machine Co. Bulletin 1.

Horizontal extrusion presses. Hydropress, Inc. Bulletin 3.

36-page pictorial story of the Cecostamp. Chambersburg Engineering Co. Bulletin 4.

Cutting Oils. Cities Service Oil Co. Bulletin 5.

Presses for Powder Metallurgy. F. J. Stokes Machine Co. Bulletin 7.

This company has issued two new booklets showing new price lists for sintered carbides. Firth-Sterling Steel Co. Bulletin 486.

Safe-T tongs and their use in materials handling are described in new booklet by Heppenstall Co. Bulletin 434.

Information and data on straightening press. Anderson Bros. Mfg. Co. Bulletin 10.

Mounted wheels, Handee and Hi-Power tools. Chicago Wheel & Mfg. Co. Bulletin 21.

Catalog 44 is a new and enlarged reference to Kennametal tools and products. Graphically indexed, this 48-page catalog covers many metal working features. Kennametal, Inc. Bulletin 541.

Forging presses. Ajax Mfg. Co. Bulletin 2.

Air tools in steel mills and foundries are pictured in new booklet by Ingersoll-Rand. Bulletin 255.

Practical data sheet describes cutting and grinding compound. Diversey Corp. Bulletin 447.

Surface coated abrasive belts. Minnesota Mining & Mfg. Co. Bulletin 12.

Complete and valuable study of "Machining of Metals", including chip formation, is offered by National Refining Co. Bulletin 335.

Pictorial 6-page leaflet describes use of Norton Co.'s resinoid grinding wheels on snagging jobs. Bulletin 550.

Attractive 16-page booklet scribes the new "MX" grinding to citing many features and appli tions. Carborundum Co. Bulle 518.

Struthers Wells Corporation's T gent Bender and its ability to e bend sheet metal in the ligh gauges is described in illustra 8-page leaflet. Bulletin 520.

8-page general catalog outlines hard facing alloys and overlay m als of this company, with m illustrations and typical applicati Wall-Colmonoy Corp. Bulletin 4

Attractive new bulletin descri the Spencer Turbine Co.'s Sump-V a new portable vacuum produ which is said to clean machine su tanks in 2 to 10 min. Bulletin 4

Steam drop hammers up to 75 pounds are described in book offered by Erie Foundry Co. Bu tin 562.

DoAll Zephyr cutting machi and its many advantages for me and other materials is described new illustrated literature. Co nental Machines, Inc. Bulletin 5

Facilities of Peerless Tool & E neering Co. for tool building and t design are described in literat available in Bulletin 597.

Use Handy Coupon Below for Ordering Helpful Literature.

Other Manufacturers' Literature Lis on pages 1340, 1342, 1346, 1354, 1356, 1 1360, 1362, 1364, 1366, 1368, 1370, 1 1374 and 1376.

Metal Progress 7301 Euclid Ave., Cleveland 3, Ohio December, 19

Send me the Literature I have indicated below.

Name .....**Title** .....

Company .....**Address** .....

(Students—please write direct to manufacturers.)

Check or circle the numbers referring to literature described on these 16 pages.

1	62	117	155	192	323	366	434	465	502	532	562	589	612
2	65	118	156	193	324	367	436	470	506	533	563	590	613
3	66	119	158	197	327	368	437	471	508	534	564	591	614
4	70	123	161	199	328	369	440	472	511	535	565	593	615
5	71	128	162	200	329	372	445	477	512	536	566	594	616
7	72	132	164	203	331	380	446	478	513	539	567	595	617
8	79	134	167	213	333	383	447	481	515	541	568	597	618
10	82	135	170	215	335	385	448	483	516	542	570	598	619
12	85	137	171	246	337	388	449	484	517	543	571	599	620
21	89	139	172	255	338	390	450	486	518	544	572	600	621
25	94	141	173	258	339	399	452	487	520	545	574	602	622
26	96	142	176	271	343	404	453	491	521	549	575	603	623
33	97	143	177	296	345	406	454	492	522	550	576	604	624
35	102	146	179	297	347	407	455	493	525	551	577	605	625
40	103	147	180	305	353	409	457	494	526	552	578	606	626
41	106	148	182	307	359	410	458	495	527	553	579	607	627
42	107	149	185	314	361	420	459	497	528	554	580	608	628
45	114	150	186	318	362	424	461	499	529	557	583	609	629
51	115	152	189	319	363	428	462	500	530	558	584	610	630
56	116	154	190	322	364	433	463	501	531	560	585	611	631

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Your orders for 52100 stock tubing will be shipped within 24 hours after they are received at Canton. Prompt delivery is possible because we maintain 99 sizes of this fine tubing in our mill stock at all times. Sizes range from 1″ O.D. x .581″ I.D. to 9.228″ O.D. x 7.144″ I.D.

Seamless 52100 steel tubes have been a specialty of our Steel and Tube Division for many years. This long experience plus exact and precise manufacturing practices carried out by one organization from melt shop through finished tube inspection have enabled us to produce a material of unexcelled and uniform quality. In addition to its wide acceptance by the anti-friction bearing industry, many other uses are found for 52100 tubing for general mechanical tube applications.

For prompt deliveries - - for dependable quality - - mail, wire or phone your orders for 52100 seamless tubes to Steel and Tube Division, The Timken Roller Bearing Company, Canton 6, Ohio.

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SEAMLESS STEEL TUBES

WHAT'S NEW

IN MANUFACTURERS' LITERATURE

Properties and uses of cutting oils. Gulf Oil Corp. Bulletin 8.

FERROUS METALS

Speed Case and Speed Treat cold finished bars are described in detail in a new profusely illustrated 24-page bulletin issued by the Monarch Steel Co. Bulletin 551.

A new heat treating guide which should prove a great convenience and time saver has just been completed by Carpenter Steel Co. In easy-to-use form this slide chart gives complete information on heat treatment of all Carpenter matched tool steels. Bulletin 604.

Spindle speed calculator is handy chart to figure machining rates on bar steels. Bliss & Laughlin, Inc. Bulletin 333.

136-page, pocket-size handbook of special steels — newly revised and reprinted—describes properties, uses and best methods of handling, treatment, etc., of tool, stainless and other alloy steels. Allegheny Ludlum Steel Corp. Bulletin 575.

Properties of Frequently Used Carbon and Alloys Steels is title of big, new booklet issued by Bethlehem Steel Co. Bulletin 580.

Republic Steel Corp.'s second edition of National Emergency Steels tells you all about these new steels. Bulletin 345.

New 46-page booklet, "Wear, A Discussion of the Mechanism of Wear Phenomena and Influencing Factors", is said to be the first book in English on the subject of wear. Nitralloy Corp. Bulletin 539.

Page after page of useful technical data and reference tables on tool steels. Latrobe Electic Steel Co. Bulletin 367.

Steel Data Sheets. Wheelock, Lovejoy & Co. Bulletin 25.

Molybdenum wrought steels. Molybdenum Corp. of America. Bulletin 26.

Chemical analyses, shapes and sizes of Joslyn stainless steel products. Joslyn Mfg. and Supply Co. Bulletin 297.

Enameling iron sheets. Inland Steel Co. Bulletin 33.

Loose-leaf reference book on molybdenum steels. Climax Molybdenum Co. Bulletin 35.

Attractive new catalog describes the line of steel offered by Peninsular Steel Co. Bulletin 337.

HWD hot work die steel and Sterling stainless steels are described in four new leaflets by Firth-Sterling Steel So. Bulletin 323.

Aircraft Alloy Steels. Joseph T. Ryerson & Son, Inc. Bulletin 40.

New Catalog C makes it easy to get International Nickel Co. literature, as it presents brief description and index to a wide variety of booklets. Bulletin 305.

"Graphitic Booklet" gives complete information on new, free-machining, long-wearing steel. Steel & Tube Div., Timken Roller Bearing Co. Bulletin 307.

New booklet gives full information on N-A-X high tensile and N-A-X 9100 Series of alloy steels. Great Lakes Steel Corp. Bulletin 328.

Kinite alloy tool steel bar stock. H. Boker & Co., Inc. Bulletin 258.

84-page tool and die steel handbook just issued by Ziv Steel & Wire Co. is a helpful guide to selection, treatment and use of these important steels. Bulletin 440.

New 38-page handbook for designers of stainless steel equipment gives valuable information for accurately proportioning stronger lighter parts. It is said to be the first time such detailed values for commercial stainless, both above and below the yield point have been compiled. American Rolling Mill Co. Bulletin 553.

Latest data chart, Section D, No. 1, shows government "specs" for alloy steels and corresponding commercial designations. Peter A. Frasse & Co., Inc. Bulletin 533.

32-page booklet which pictorially and textually amounts to a scientific treatise on two carbon steels—Speed Case and Speed Treat — has been issued by W. J. Holliday & Co. Bulletin 450.

Molybdenum-Tungsten high speed steels marketed under the general trade name Mo-Max are discussed comprehensively in 52-page book by J. V. Emmons, metallurgist for the Cleveland Twist Drill Co. Bulletin 497.

Important practical heat treating information about stainless steels has just been issued by Rustless Iron and Steel Corp. Bulletin 563.

Facts on Beryllium Copper, including composition, forms available, applications and extensive additional information are presented in this new 16-page booklet by the Riverside Metal Co. Bulletin 511.

Fitzsimons Co. issues interesti leaflet on speed case and speed tr steels. Bulletin 452.

SKF Steels, Inc., has issued a st list of high carbon-high chro seamless steel tubing and round b available for immediate delive Bulletin 566.

NON-FERROUS METALS

Reynolds Metals Company issued two new bulletins, "Extru Shapes bulletin 35A and a gene bulletin covering a number of R nolds products. Both are attr tively presented and 8 pages. Bulle 629.

36-page booklet outlines v briefly the description of vari ASTM, AMS, SAE and governm specifications for nonferrous st tural material. Central Steel & W Company. Bulletin 613.

Publication of a new bulletin, N Ferrous Forgings Digest, has b started by the Brass Forging A It will be issued periodically. Bu tin 615.

80-page pipe and tube bendi handbook has been issued by Cop & Brass Research Assn. Bulletin 3

Copper Alloys. American Brass Bulletin 45.

Platinum Metal Catalysts. Bake Co., Inc. Bulletin 41.

6th edition of Revere Weights Data Handbook. Revere Copper Brass, Inc. Bulletin 296.

Die casting equipment. Les Phoenix, Inc. Bulletin 42.

This "Aluminum Imagineeri Notebook" presents 12 import economic advantages of alumin and illustrates numerous examp of things which have been ima neered into aluminum actualiti Aluminum Co. of America. Bulle 472.

"Designing with Magnesium" is tle of new book offered by Americ Magnesium Corp. Bulletin 433.

Two new Ampco Metal data she discuss forging Ampco to impro physical characteristics and use Ampco for non-scratching feed f gers. Bulletin 314.

32-page booklet, "Revere Mag sium Alloys and the Light Met Era", is now coming off the pr with basic facts about magnesi plus detailed technical data on ph ical, mechanical and working ch acteristics of the Revere Allo Revere Copper and Brass, Inc. B letin 579.

Use Handy Coupon on Page 1338 for Ordering Helpful Literature.

Other Manufacturers' Literature Listed on pages 1338, 1342, 1346, 1354, 1356, 1358, 1360, 1362, 1364, 1366, 1368, 1370, 1372, 1374 and 1376.

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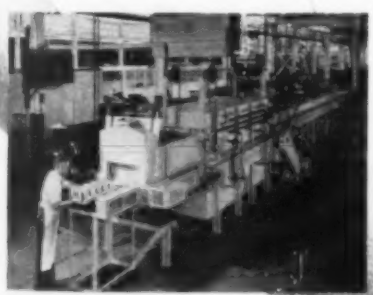
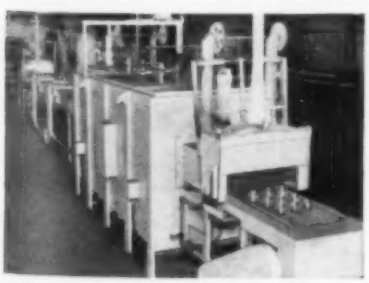
INDUSTRIAL HEAT-TREATING



This continuous roller hearth furnace is ideal for production-line bright annealing, copper brazing and sintering. It is built for either manual or automatic charging or discharging. Exogas is used for low carbon parts and Endogas for medium and high carbon parts.



Continuous belt conveyor furnace used for copper-brazing lightweight ferrous assemblies in Exogas atmosphere. This furnace is suitable for brazing various types of small machine or pressed parts, and also for annealing and sintering.

There's new help in this book on modern Westinghouse electric heat-treating furnaces for every type of industrial heat-treating, either small-lot or production-line work.

Used with the proper atmospheres, Westinghouse furnaces sharply reduce machining and cleaning operations in most cases and their precise control virtually eliminates rejects. Product uniformity is assured.

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Ask your nearest Westinghouse office for your copies of these two books, or write Westinghouse Electric & Mfg. Co., P. O. Box 868, Pittsburgh 30, Pa. J-10270

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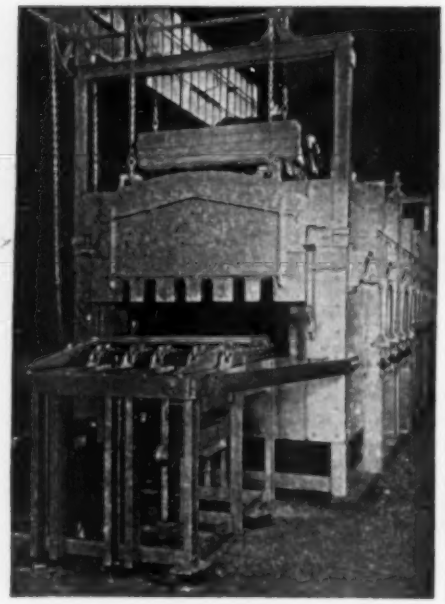

● In the construction of Bellevue Furnaces, painstaking consideration of the job to be done comes first. Every factor must be evaluated, every condition studied. Only then do Bellevue engineers attempt design and recommendation of furnace type.

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WHAT'S NEW

IN MANUFACTURER'S LITERATURE

Rare metals, alloys and ores. Foote Mineral Co. Bulletin 56.

Printed information on Lithium of interest to nonferrous and physical metallurgists is available from Lithaloys Corp. Bulletin 532.

Red-X Aluminum Alloys, produced by the largest single producer of Commercial Aluminum and Magnesium Alloys, the National Smelting Co., are described, applications studied, in this 16-page file folder. Bulletin 499.

"Some Considerations in Making Test Bars" is the title of an interesting booklet by Federated Metals Div., American Smelting and Refining Co. Bulletin 529.

Dowmetal data book. Dow Chemical Co. Bulletin 51.

WELDING

New, informative book on Page-Allegheny stainless steel welding electrodes includes suggestions on selection of proper electrode and welding procedures. Page Steel and Wire Div., American Chain & Cable Co. Bulletin 621.

New method for increasing speed of welding mild steel called "Fleet-Welding" is described in new 48-page booklet issued by the Lincoln Electric Co. Bulletin 571.

This new chart gives weld metal chemical composition, heat treatment specifications and identifying grade information on Arcos Corp.'s stainless and alloys electrodes. Bulletin 572.

Bulletin GEA-4220, well-illustrated, describes features of new current regulating compensator for resistance welding. General Electric Co. Bulletin 576.

"Things To Know About Welding Stainless Steel" is title of new booklet that answers many welding questions. The McKay Co. Bulletin 544.

40-page catalog reviews the progress and many applications of low temperature welding. Eutectic Welding Alloys Co. Bulletin 471.

Oxy-acetylene welding and cutting. Linde Air Products Co. Bulletin 62.

Welding and brazing of aluminum, a new data book issued by Aluminum Co. of America. Bulletin 66.

16-page booklet illustrates the design and construction features of certain types of Victor single and two-stage reduction regulators employed in the welding industry. Victor Equipment Co. Bulletin 552.

Data book facts on spot, seam and flash welding ferrous and non-ferrous metals and alloys. P. R. Mallory & Co., Inc. Bulletin 65.

Comparable arc welding electrodes for stainless are shown in chart issued by Alloy Rods Co. Bulletin 353.

New Phos-Copper booklet explains ways to braze, design and applications. Westinghouse. Bulletin 455.

32-page booklet presents numerous experience reports from large users of arc welding. General Electric Co. Bulletin 513.

Air Reduction Sales Co. offers 20-page revised price list, "Gas and Electric Welding Supplies and Accessories". Bulletin 512.

Bulletin No. 14, "How To Repair Broken Cutting Tools With Easy-Flo", is filled with practical, instructional copy, profusely illustrated. Handy & Harman. Bulletin 506.

Pocket-sized, slide-type guide showing proper tip sizes, gas pressures, and other data required for machine gas-cutting steel is offered by Air Reduction. Bulletin 527.

End-welding with Nelson studs in less than ½ second is described in catalog and price list issued by Nelson Specialty Welding Equipment Corp. Bulletin 565.

TESTING & INSPECTION

Two new leaflets describe the "Tukon" tester for determination of Knoop hardness numbers and the "Equitron" fixture for supporting and positioning samples in Rockwell testing. Wilson Mechanical Instrument Co., Inc. Bulletin 628.

Attractive 8-page leaflet describes the line of Riehle testing machines and instruments, picturing the details of many and indicating their application. Riehle Testing Machines Div. of American Machine and Metals, Inc. Bulletin 625.

Bibliography of more than 700 papers dealing with the polarographic method of metal analysis and a booklet discussing this equipment is offered by E. H. Sargent & Co. Bulletin 338.

Use Handy Coupon on Page 1338 for Ordering Helpful Literature.

Other Manufacturers' Literature Listed on pages 1338, 1340, 1346, 1354, 1356, 1358, 1360, 1362, 1364, 1366, 1368, 1370, 1372, 1374 and 1376.

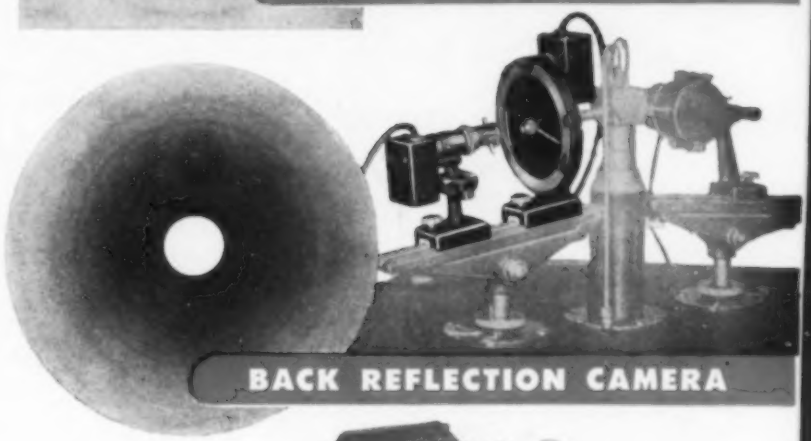
The Laue Camera is used for the observation of preferred orientation of grains or fiber textures and the study of cold work and recrystallization.

Typical Laue Camera Diffraction Pattern; shows preferred orientation.

LAUE CAMERA

The Back Reflection Camera is used for precise measurement of lattice constants, measurement of surface stresses, observation of distortion in crystals and the determination of composition of solid solution alloys. Sample and film may be rotated by motor.

Typical Back Reflection Camera Diffraction Pattern



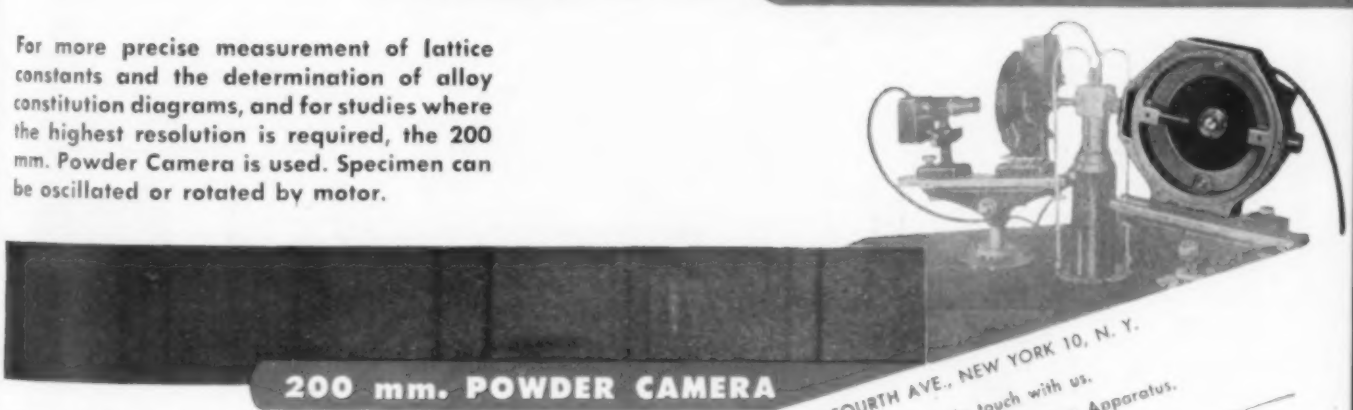
BACK REFLECTION CAMERA

For routine identification of substances or unknowns the 70 mm. Powder Camera is used. Specimen can be rotated by motor.

Typical 70 mm. Powder Camera Diffraction Pattern.

70 mm. POWDER CAMERA

For more precise measurement of lattice constants and the determination of alloy constitution diagrams, and for studies where the highest resolution is required, the 200 mm. Powder Camera is used. Specimen can be oscillated or rotated by motor.



200 mm. POWDER CAMERA

Typical 200 mm. Powder Camera Diffraction Pattern. Note the greater resolution of lines as compared with the 70 mm. pattern of the same area above.

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WHAT'S NEW
IN MANUFACTURERS' LITERATURE

6-page leaflet describes the Leitz-Blosjo carbon meter for determining the carbon content of samples chill cast from molten steel. E. Leitz, Inc. Bulletin 603.

"Faxfilm", a new economical, quick method of inspecting surface finishes through enlarged Three Dimensional Replica, is described and illustrated in an interesting 4-page leaflet by Rex D. McDill. Bulletin 602.

New Burrell Shaker for general laboratory use is described in new catalog issued by Burrell Technical Supply Co. Bulletin 543.

The Bristol-Rockwell dilatometer and its use is described in this leaflet by The Bristol Co. Bulletin 465.

Metallurgical polishing equipment offered by Precision Scientific Corp. is described in illustrated booklet. Bulletin 359.

Various methods and specific applications of the measurement of case depth are described in illustrated pamphlet offered by Allen B. DuMont Laboratories, Inc. Bulletin 339.

SR-4 strain gage and illustrations of its many uses. Baldwin Southwark. Bulletin 70.

X-Ray Diffraction Unit. General Electric X-ray Corp. Bulletin 72.

New book contains wealth of practical, usable information on industrial inspection by x-ray. Westinghouse Electric & Mfg. Co. Bulletin 71.

Latest technical literature on x-ray and radium protection, together with lead products catalog, has been issued by Bar-Ray Products, Inc. Bulletin 463.

Industrial radiography with radium. Canadian Radium & Uranium Corp. Bulletin 79.

Portable Brinell hardness tester and folding Brinell microscope. Andrew King. Bulletin 85.

Optical Aids. Bausch & Lomb Optical Co. Bulletin 94.

Metallographic polishing powder. Conrad Wolff. Bulletin 96.

Metallurgical Equipment. Adolph I. Buehler. Bulletin 97.

Use Handy Coupon on Page 1338 for Ordering Helpful Literature.

Other Manufacturers' Literature Listed on pages 1338, 1340, 1342, 1354, 1356, 1358, 1360, 1362, 1364, 1366, 1368, 1370, 1372, 1374 and 1376.

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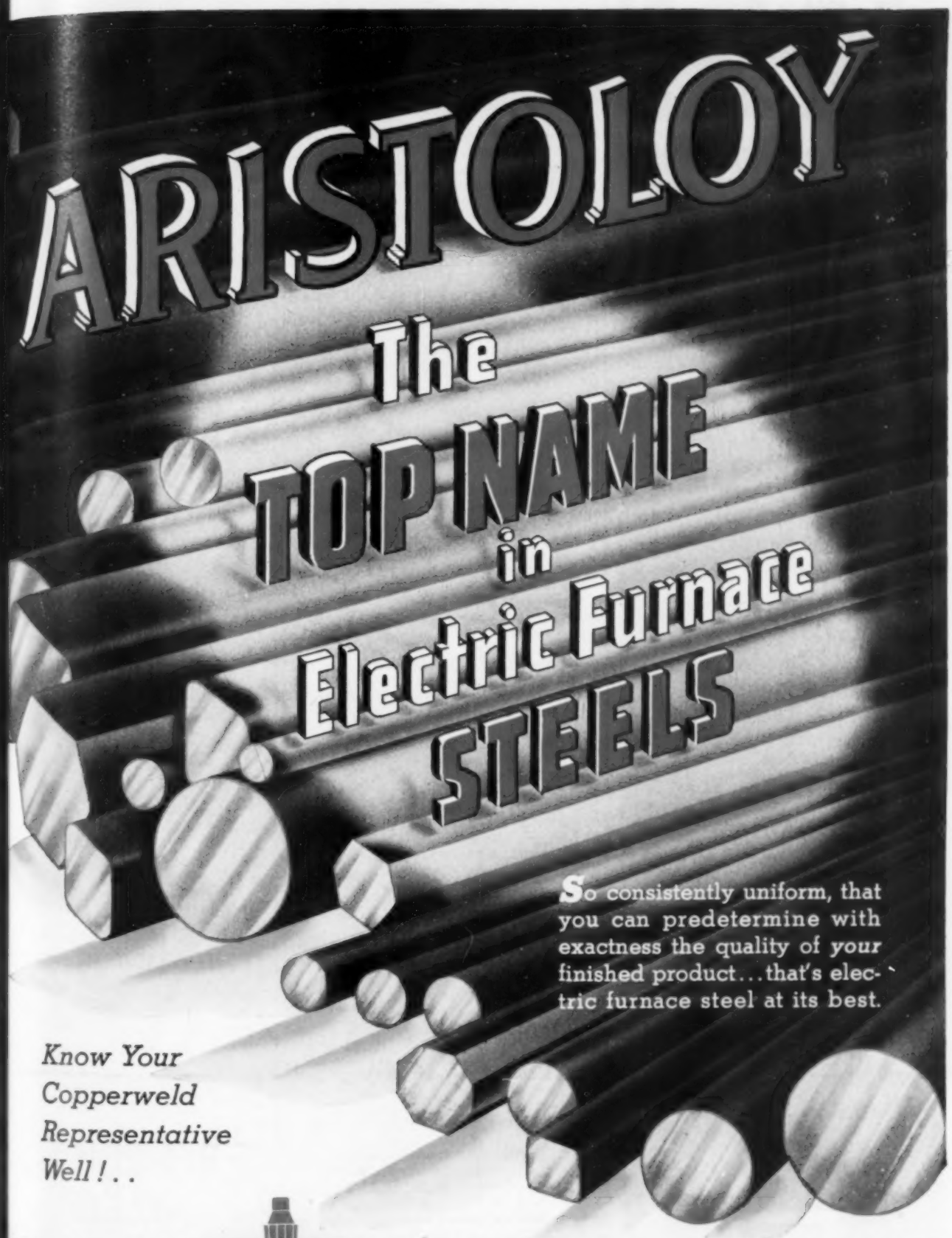
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WHAT'S NEW

IN MANUFACTURERS' LITERATURE

New Norelco electronic Searchray Modal 150 is described and several features illustrated in this 4-page leaflet. North American Philips Co., Inc. Bulletin 517.

"Radiography of Materials" is title of new 96-page book on industrial radiography. Eastman Kodak Co. Bulletin 331.

High intensity industrial illuminator is illustrated and described in new leaflet by Kelley-Koett Mfg. Co. Bulletin 406.

30th Anniversary Catalog shows the special metallurgical equipment offered by Claud S. Gordon Co. Bulletin 410.

Details and various applications of the portable tensile tester are shown in 8-page leaflet by W. C. Dillon & Co., Inc. Bulletin 491.

Advantages and speed of testing with the Magnetic Analysis Corp.'s Comparator are described and pictured in brochure just released. Bulletin 492.

8-page illustrated leaflet describes line of industrial instruments offered by the Brush Development Co. Bulletin 428.

New Carbon and Sulphur Determinator is described in this new 8-page leaflet. Harry W. Dietert Co. Bulletin 501.

Many tips and suggestions for industrial laboratories are presented in 24-page March issue of "Curves and References" by Wilkens-Anderson Co. Bulletin 502.

4-page folder on the inspection and control of surface finish is offered by George Scherr Co. Bulletin 508.

6-page leaflet describes the constant temperature equipment offered by American Instrument Co. Bulletin 493.

New 50 KV industrial x-ray unit, its features and applications, are presented in this 8-page leaflet. Picker X-Ray Corp. Bulletin 525.

Attractive, illustrated booklet describes Clark Instrument's precision hardness tester. Bulletin 318.

Use Handy Coupon on Page 1338
for Ordering Helpful Literature.
Other Manufacturers' Literature Listed
on pages 1338, 1340, 1342, 1346, 1356, 1358, 1360, 1362, 1364, 1366, 1368, 1370, 1372, 1374 and 1376.

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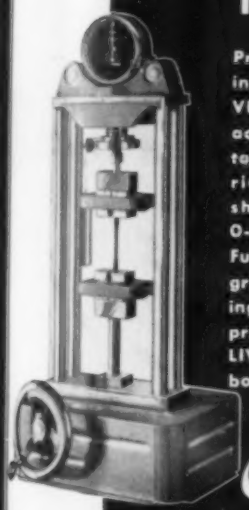

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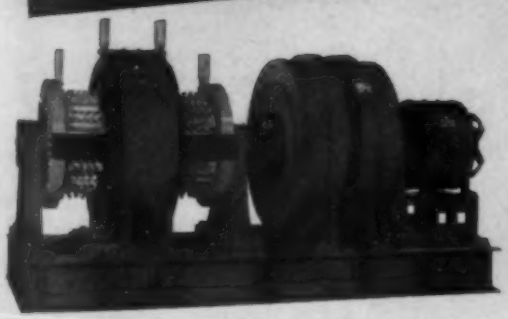

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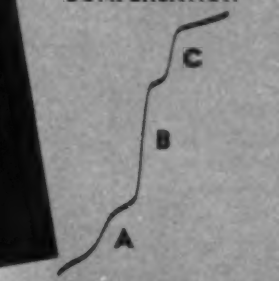

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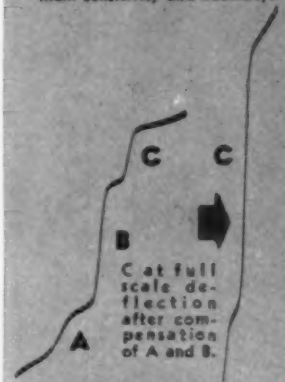
Constituent C is the element to be determined, but under the conditions illustrated, the concentrations of constituents A and B are so large that C cannot be measured at maximum sensitivity and accuracy.



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This clearly illustrates the important advantages of current compensation . . . constituent C can now be measured with maximum accuracy and without the necessity for time-consuming chemical removal of constituents A and B.

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WHAT'S NEW

IN MANUFACTURERS' LITERATUR

TEMPERATURE CONTROL

Method for holding constant t temperature of electrically heate salt pots is described in a new 8-pa bulletin just issued by Leeds Northrup Co. Bulletin 627.

The Rheotrol, for maintaining d sired power or heat input or flow liquids or gases, and the new aut matic and manual type Inputrols, a described in two new 4-page leafle by Wheelco Instruments Co. Bull tin 611.

An 8-page leaflet describing a ne line of air-operated controller known as the Model 93 series, h just been issued by the Bristol C Detailed information is given abo the instruments for the control te perature, pressure, vacuum, liqui level, humidity and flow. Bulleti 612.

Ratio Control and its applicatio to many types of proportioning i the process industries is describe in this 16-page booklet by Askan Regulator Co. Bulletin 616.

Potentiometer temperature indic tors. Foxboro Co. Bulletin 82.

Micro-Optical Pyrometers. Pyro eter Instrument Co. Bulletin 89.

Pyrometer control of high spe salt baths is described in new boo let by Brown Instrument Co. Bull tin 324.

Operating principle and typ available of the synchronous-moto driven cam program timer are co ered in this new 4-page folde Automatic Temperature Control C Inc. Bulletin 487.

Alnor Pyrocon, the contact pyro eter for surface temperatures, described in this 6-page leaflet Illinois Testing Laboratories, In Bulletin 558.

HEATING • HEAT TREAT MENT

Internally heated salt bath furnac and pots. Upton Electric Furna Div. Bulletin 102.

This 12-page booklet is a compr hensive discussion of "interrupted quenching in salt. E. F. Houghton Co. Bulletin 620.

Use Handy Coupon on Page 1338 for Ordering Helpful Literature.
Other Manufacturers' Literature Lite on pages 1338, 1340, 1342, 1346, 1354, 13 1360, 1362, 1364, 1366, 1368, 1370, 13 1374 and 1376.

COLMONOY

COLMONOY HARD-FACING WELDING RODS AND ELECTRODES

	Name	Rockwell C Hardness	Specific Gravity	Melting Point °F	Approximate Composition %	Characteristics of Hard-Facing	Typical Uses
FERROUS ALLOYS	COLMONOY NO. 1	58 to 62	7.70	2400°	Cr. 7-11 B. 1-2 Si. 2-4 Fe. Bal.	Very high wear-resistance. Shock resistant. Non-machinable.	For relatively large areas of thick overlay which must withstand shock and abrasion, such as dipper teeth, bucket lips, drag chains, hot guides, roller guides, etc.
	COLMONOY NO. 9	64 to 67	7.91	2300°	Cr. 7-11 B. 1-2 Mo. 12-16 Fe., Bal.	Very high wear-resistance. Eigh red-hardness. Great toughness. Non-machinable.	Tipping metal and rock cutting tools. Also used, successfully on such wearing parts as reamers, broaches, grinder rests, etc.
	COLMONOY WCR 100	65 to 68	8.01	2350°	Cr. 8-12 B. 2-3 W. 13-17 Fe. Bal.	Excellent wear and indentation resistance. Holds good cutting edge. Heat treatment ,1500°-2000° range, adds toughness.	For tipping special cutting tools.
NICKEL ALLOYS	COLMONOY NO. 6	55 to 60	6.65	1925°	Ni. 63-73 Cr. 15-22 B. 3-5 Fe. Si. C. 10 max.	Very high wear-resistance. Very high corrosion-resistance. Non-machinable.	For hard-facing parts to resist wear, corrosion, heat and galling, such as shaft sleeves, liquid and rods, hot oil plungers, thrust collars, seal rings, steam valve trim, etc.
	COLMONOY NO. 5	45 to 50	6.84	1950°	Ni. 71-81 Cr. 10-17 B. 2-4 Fe. Si. C. 9 max.	High wear-resistance. Very high corrosion-resistance. Machinable with carbide tools.	For hard-facing wearing parts that must be machined, and which will be exposed to severe wear and corrosion, such as pump sleeves, wear rings, plungers, etc.
	COLMONOY NO. 4	35 to 40	6.91	2025°	Ni. 75-85 Cr. 8-14 B. 2-3 Fe. Si. C. 8 max.	Good wear-resistance. Very high corrosion-resistance. Machinable with carbide tools.	Particularly suitable for valves and other similar wearing parts which must be machined.
	COLMONOY NO. 20	15 to 20	7.17	2225°	Ni. 80-90 Cr. 5-9 B. 1-2 Fe. Si. C. 7 max.	Very high corrosion-resistance. Machinable with high-speed tools.	For repairs, such as mending defects in cast-iron, or for smoothing flaws in die casting molds. In general, the hardness should be comparable to that of the surface being repaired.

*Note—Rockwell hardness readings are not an accurate indication of the wear resistance of Colmonoy. Experience has shown that Colmonoy hard surfaces resist wear several times as long as many other hard-facing alloys which may have even higher Rockwell hardness readings.

HARD FACING WELDING RODS AND ELECTRODES

Colmonoy Alloys are of particular interest to those responsible for product design. Used on those parts of the finished product subject to excessive wear or corrosion, they increase its life and efficiency. Used on the wearing parts of production machinery, they lower costs by providing uninterrupted operation, and less down time. Catalog No. 75 describes the many grades of Colmonoy and illustrates many typical product and machine applications.

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Because heat treating procedures modified to individual part requirements may be determined in the Pilot Furnace, consistent accurate production results will be forecast in test and give full confidence that production schedules and technique are set up correctly.

The COOLEY ELECTRIC HEAT TREATING MUFFLE FURNACE is built in two sizes, chamber dimensions, Model MH-3, 8″ wide by 6″ high by 14″ deep, Model MH-4, 10″ wide by 6″ high by 18″ deep. Its advanced design incorporates many features of industrial furnaces, viz., heavy cast iron frames, substantial insulation and cast nickel chromium hearth plate. Elements are readily removable for renewal. It is of simple design, substantial in structure and economical in operation.

Chamber temperature uniformity, so necessary for correct analysis, is inherent in this furnace design and temperature control apparatus of various types—millivoltmeter controllers, potentiometer controllers, input controllers, or proportioning controllers, may be selected to secure the degree of accuracy of temperature control considered necessary for the application.

MANY OTHER PROFITABLE USES:

1—**AS A PRODUCTION UNIT**—or for plant maintenance and emergency repair.

2—**HARDENING SMALL MACHINE PARTS**—Do your own heat treating—avoid delays of relying upon overcrowded commercial heat treaters.

3—**DRAWING OR TEMPERING**—Use it as auxiliary equipment—save expense of using large furnaces for small parts.

4—**NORMALIZING OR ANNEALING SMALL PARTS**—Handles this work easily and quickly—save time and money.

5—**PRE-HEATING FOR HIGH-SPEED HARDENING**—or for use on miscellaneous small parts.

6—**EMERGENCY REPAIR ORDERS**—Use it to handle them immediately and conveniently—prevent shut-downs.

7—**EXPERIMENTAL TESTING**—Use it for industrial or laboratory testing and development work.

Construction Features

- Cool element terminals of large wire section welded to the coils completely avoid a common source of trouble
- Insulation is of high temperature resisting slabs having a minimum of through joints, an essential in avoiding heat loss.
- The shell is of heavy sheet steel, supported and confined by substantial cast iron end frames.
- Cast iron front plates and molded refractory vestibules eliminate the use of transite and its attendant maintenance due to cracking and chipping under heat.
- These features, many of which are usually found only in large industrial furnaces, insure stability, maximum efficiency and economy of operation.

FREE DATA BULLETIN!

Complete data covering specifications, additional applications and ordering instructions are included in this new bulletin. Write for your copy today. Ask for Bulletin No. 50.

COOLEY ELECTRIC MANUFACTURING CORP.
36 South Shelby Street Indianapolis 7, Indiana

WHAT'S NEW
IN MANUFACTURERS' LITERATURE

Rectangular pot furnaces, the... specifications and construction, ar... presented by Eclipse Fuel Engineer... ing Co. in this Bulletin 630.

Dempsey Industrial Furnace Corp... analyzes and discusses the advan... tages of immersed electrode salt bat... heat treating in a new booklet, Bul... letin 631.

New bulletin MP115 describes A... F. Holden Co.'s flow heat treatmen... for bright hardening, bright temper... ing and hot quenching. Bulletin 56...

Lithium Metallic Vapor atmospher... furnaces, principles and data, ar... presented in this illustrated 20-pag... booklet. Lithium Co. Bulletin 60...

Spotting Surface Combustion fu... naces out of the heat room and int... the production lines is described i... this leaflet. Bulletin 607.

Rotary carburizing furnaces—ga... oil and electric—are illustrated an... described in this 4-page leaflet b... W. S. Rockwell Co. Bulletin 608.

24-page Catalog Section M-8802 d... scribes Karbate corrosion resistan... heat exchange equipment. Booklet... sets forth several charts and table... covering heat conductivity and phy... ical and chemical properties of ca... bon, graphite and Karbate materials... National Carbon Co., Inc. Bulleti... 570.

Electric Furnaces. Ajax Electro... thermic Corp. Bulletin 106.

Radio frequency generators f... cutting heating time are describe... by Westinghouse Electric & Mfg. C... in Bulletin B-3261-A and Descriptiv... Data 85-800. Bulletin 577.

40-page booklet contains comple... information on cold treating, inclu... ing new procedures, application... performance data stories, etc. Dec... freeze Div., Motor Products Cor... Bulletin 578.

Junior Quencher for controlle... quenching where small pieces a... heat treated is described in 4-pa... leaflet by Bell & Gossett Co. Bulleti... 591.

"Isothermal Quench Baths Appli... to Commercial Practice" is the ti... of this 12-page paper, a practic... and useful discussion of S curves ... heat treatment. Ajax Electric C... Inc. Bulletin 461.

Use Handy Coupon on Page 1338 for Ordering Helpful Literature.

Other Manufacturers' Literature Liste... on pages 1338, 1340, 1342, 1346, 1354, 135... 1360, 1362, 1364, 1366, 1368, 1370, 137... 1374 and 1376.

Easier TO USE

....that's why they choose AIR TOOLS

Here are several reasons why operators find air tools easy to handle:

- They are about one-half the size of other types of portable power tools. Consequently, they are lighter in weight. This means that operator fatigue is kept at a minimum.
- Air motors cannot be damaged by overloading. This feature, plus sturdy construction, assures trouble-free service.
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- Power regulation permits the use of air tools on many kinds of materials and many types of operations.
- Starting and stopping are practically instantaneous. Air tools give maximum power immediately.
- Compressed air is the safest method for the transmission of power for portable tools. Air tools are safe.

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Air Motors	Hoists	Rock Drills	Sump Pumps
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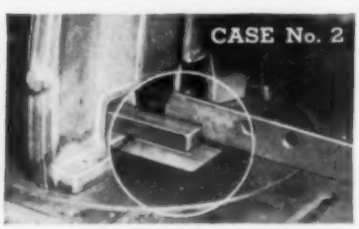
5 CASES WHERE KENNAMETAL INSERTS *Take a licking and like it!*

Condition: Grinder table had to be resurfaced frequently to maintain true grinding of tool angles.

Correction: Kennametal inserts provide true, flat surfaces that show no appreciable wear after many months' service.



Condition: Worn sliding surfaces of abrasive saw rest allowed shank steel to wobble, causing uneven cut-off.

Correction: Inserts of Kennametal make smooth surface that outwears steel up to 100 times.

Condition: Steel parts of vise clamping mechanism badly galled by twisting action.

Correction: Kennametal discs, at abutting points, minimize wear; permit jaw to be closed securely, opened readily with less effort.

Condition: Wire cleaning brushes cut deep into steel leveling guides in less than one day.

Correction: Kennametal inserts resist the abrasion . . . after months' service, are still in good shape.

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Correction: Inserts of wear-resistant Kennametal provide non-galling surfaces that guide the saw straight and true.

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If the service life of your products or production machinery is shortened by excessive wear . . . incorporate extremely hard, non-galling Kennametal parts at critical points. Kennametal is available in a variety of standard shapes (balls, discs, flat blanks), and it can be molded into almost any special form, limited only by reasonable proportions. Write for catalog information.

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SUPERIOR CEMENTED CARBIDES
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WHAT'S NEW

IN MANUFACTURERS' LITERATURE

New 12-page fully-illustrated bulletin on heat treating ovens has just been published by Young Brothers Co. Illustrated are typical examples of ovens for heat treating aluminum and magnesium parts, for aging, stabilizing and hydrogen relief of plated parts, for pre-heating, for temper drawing and for stress relief. Bulletin 599.

Chapmanizing imparts costly alloy-hardness to steels faster than any other process, according to literature available from the Chapman Valve Mfg. Co. Bulletin 600.

Convection tempering furnaces with temperatures up to 1300 deg. F. are described in this new Hevi Duty Electric Co. Bulletin 542.

32-page booklet describes 16 interesting industrial uses of high frequency electrical induction. Ohio Crankshaft Co. Bulletin 459.

8-page pictorial bulletin describes the heat treating service of Continental Industrial Engineers, Inc. Bulletin 107.

Quenching oil coolers in heat treating practices are described in this leaflet by the Sims Co. Bulletin 462.

Induction heating. Induction Heating Corp. Bulletin 103.

Furnaces for heat treatment of aluminum, magnesium and their alloys. Lindberg Engineering Co. Bulletin 271.

Gas, oil, and electric heat treating and carburizing furnaces. Holcroft & Co. Bulletin 114.

56-page vest pocket data book on heat treating practices and procedures. Chicago Flexible Shaft Co. Bulletin 118.

Industrial furnaces, equipment for bright annealing stainless steels and ammonia dissociation equipment. Drever Co. Bulletin 115.

Industrial ovens, rod bakers, welding rod ovens, furnaces. Carl-Mayer Corp. Bulletin 116.

Full muffle and other heat treating furnaces described in catalog by Charles A. Hones, Inc. Bulletin 117.

Non-metallic Electric Heating Elements. Globar Div., Carborundum Co. Bulletin 119.

Use Handy Coupon on Page 1338 for Ordering Helpful Literature.

Other Manufacturers' Literature Listed on pages 1338, 1340, 1342, 1346, 1354, 1356, 1358, 1362, 1364, 1366, 1368, 1370, 1372, 1374 and 1376.

What is The Continental Hypercarb Process*?

It is a mass production process for *automatically* obtaining a *uniform, clean, file hard surface,* using dependable Continental *muffleless gas carburizers.*

Custom Built by Continental

Why should you use the Continental Hypercarb Process???

Because:

Each piece is consistently *uniform* in *depth* and *hardness.* Each piece is so *clean* it may be assembled directly from the Continental unit without other work.

Each gear is free from *distortion.*

The operating cost is *low.*

How are these advantages obtained???

By *special control* of the heating cycle.

By use of special *activated gas* generator within the unit.

By special *quenching* construction.

By full *automatic* handling on a predetermined cycle including carburizing, quenching, drawing, etc.

Write for Booklets and Full Details

BEN FRANKLIN SAYS:

"Time Enough Always Proves Little Enough"

It is none too soon to plan for full peacetime production . . . nor is it too late! There's time enough for a thorough check-up by Continental engineers on your present heat treating operations.

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WHAT'S NEW

IN MANUFACTURERS' LITERATURE

Certain Curtain Furnaces. C. I. Hayes, Inc. Bulletin 134.

Molten Salt Baths. E. I. duPont deNemours & Co., Inc., Electrochemicals Department. Bulletin 123.

Handling cylinder anhydrous ammonia for metal treaters. Armour Ammonia Works. Bulletin 128.

Air-Oil Ratiotrol for proportioning flow of fuel oil and air to oil burners. North American Mfg. Co. Bulletin 135.

Two new bulletins on vertical carburizers and on carbonia finish. American Gas Furnace Co. Bulletin 139.

Controlled atmosphere furnace. Delaware Tool Steel Corp. Bulletin 141.

Dual-Action quenching oil. Gulf Oil Co. Bulletin 132.

Heat treating, brazing and melting of ferrous and non-ferrous metals. Lepel High Frequency Laboratories, Inc. Bulletin 147.

Industrial Carburetors. C. M. Kemp Mfg. Co. Bulletin 143.

Vertical Furnace. Sentry Co. Bulletin 148.

Furnaces. Tate-Jones Co. Bulletin 142.

Conveyor Furnaces. Electric Furnace Co. Bulletin 149.

High and low temperature direct fired furnaces. R. S. Products Corp. Bulletin 146.

New Electric Furnace. American Electric Furnace Co. Bulletin 150.

Pictorial bulletin describes furnaces for heat treating, normalizing, annealing, forging. Vulcan Corp. Bulletin 161.

"The Lectrodryer in the metallurgical industries," a new 4-page bulletin by Pittsburgh Lectrodryer Corp. Bulletin 155.

High Temperature Fans. Michiana Products Corp. Bulletin 158.

Turbo-Compressor data book shows how to calculate compressed air systems for a dozen different applications. Spencer Turbine Co. Bulletin 329.

Use Handy Coupon on Page 1338 for Ordering Helpful Literature.

Other Manufacturers' Literature Listed on pages 1338, 1340, 1342, 1346, 1354, 1356, 1358, 1360, 1364, 1366, 1368, 1370, 1372, 1374 and 1376.

ECLIPSE POT FURNACE

(CIRCULAR OR RECTANGULAR)

Accurate Temperature Control

No. 10 EA Pot Furnace

Scale Free Work

- MARTEMPERING
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- TEMPERING
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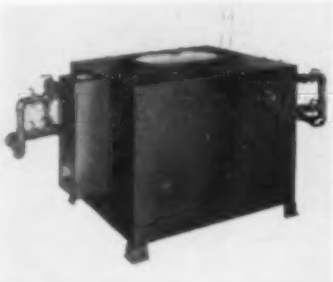
No Atmosphere Required



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Quick Heating

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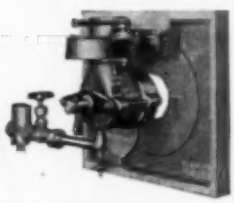
"REVERSE BLAST"



Mixes ALL the Fuel with ALL the Air.

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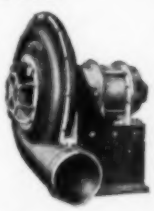

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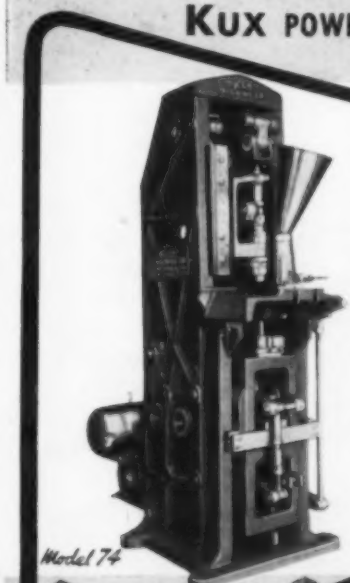

Model 74

COMPLETELY new patented design features now permit the manufacture of odd shapes of parts with complicated, cored holes, protruding lugs and various sectional thicknesses to micrometer accuracy. The formed pieces are made at speeds of up to 25 pieces a minute with uniform structural density throughout. Completely automatic in operation and applying up to 50 tons total pressure, Model No. 74 will produce parts up to 5" maximum diameter and has a powder cell, or die fill of 5¼".

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PANGBORN CORPORATION World's Largest Manufacturer of Blast Cleaning and Dust Control Equipment HAGERSTOWN, MARYLAND

★ 249

WHAT'S NEW

IN MANUFACTURERS' LITERATURE

Electric Furnaces for laboratory and production heat treatment. Hoskins Mfg. Co. Bulletin 152.

Flame-type mouth and taper annealing machine for steel cartridge cases. Morrison Engineering Corp. Bulletin 154.

No-Carb, a liquid paint for prevention of carburization or decarburization. Park Chemical Co. Bulletin 156.

Catalog of heat treating materials. Heatbath Corp. Bulletin 322.

Use of pulverized coal in the metallurgical industries, equipment and designs, are described by Amsler-Morton Co. in Bulletin 361.

Line of Altitude Chambers in which products and materials may be tested at any given altitude, temperature and degree of humidity is described in new catalog issued by Kold-Hold Mfg. Co. Bulletin 549.

"Why Heat Treat in Baths?" is the title of an interesting discussion by the Bellis Heat Treating Co. on the use of liquid heating media and the latest Edicurrent Furnaces. Bulletin 560.

Laboratory and tool room furnace. Mahr Mfg. Co. in new Bulletin 327.

82-page catalog describes in detail General Electric heat treat furnaces. Bulletin 380.

Furnaces for heat treating tools, dies and parts are described in new leaflet by Despatch Oven Co. Bulletin 362.

New booklet describes uniform case hardening up to .150" with controlled carburizing baths. American Cyanamid & Chemical Corp. Bulletin 372.

New book "Hardness" describes and evaluates hardness research of noted pioneers, methods of testing and testing instruments. Nitralloy Corp. Bulletin 366.

Four basic heat treating atmospheres are described in new booklet by Westinghouse. Bulletin 383.

The complete line of heat treating furnaces, burners and other equipment of this company is described and illustrated in new bulletin "D" just issued. Eclipse Fuel Engineering Co. Bulletin 483.

Use Handy Coupon on Page 1338 for Ordering Helpful Literature.

Other Manufacturers' Literature Listed on pages 1338, 1340, 1342, 1346, 1354, 1356, 1358, 1360, 1362, 1366, 1368, 1370, 1372, 1374 and 1376.

Research Leadership

Back of Every Ingot

The spectrographic department at Apex carefully measures the ranges of alloying elements of every heat of metal by the use of the densitometer. Such close laboratory control guides the removal of harmful elements and permits meeting the most exacting alloy specifications. This pre-testing of alloys is an important part of Apex Leadership Back of Every Ingot.

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WHAT'S NEW

IN MANUFACTURERS' LITERATURE

Vapocarb-Hump method for heat treatment of steel is the title of a newly-revised catalog issued by Leeds & Northrup. Bulletin 453.

"Heat Treating Topics" is title of new bulletin of special interest to heat treaters, issued by Rex & Erb. Bulletin 424.

112 pages packed solid with down-to-earth data on industrial combustion and heat practice. Hauck Mfg. Co. Bulletin 477.

Aero Heat Exchangers for the constant and accurate control of temperature in liquids or gases are described in this 4-page leaflet by Niagara Blower Co. Bulletin 516.

Gas-fired tool room furnaces and pot furnaces are described in these two booklets by Bellevue Industrial Furnace Co. Bulletin 522.

Merits and economy of pulverized-coal firing for metallurgical furnaces are discussed in this bulletin by Babcock & Wilcox Co. Bulletin 530.

A new technical bulletin gives information on Calliflex Bi-metal. Callite Tungsten Corp. Bulletin 478.

REFRACTORIES & INSULATION

4-page leaflet describes Hearth Patch, a fast-setting, fine-grained magnesia refractory for quick repair of deep bottom holes in basic open hearth furnaces. Basic Refractories, Inc. Bulletin 590.

Zircon refractories in aluminum open hearth furnaces. Chas. Taylor Sons Co. Bulletin 347.

Electric-furnace graphite molds and sintering boats and carbon heat treating boxes are described in Catalog Section M-8000. National Carbon Co. Bulletin 545.

"Carbofrax" refractory skid rails are described and blueprinted for many types of furnaces in this 20-page booklet by the Carborundum Co. Bulletin 500.

Conductivity and heat transfe charts. Johns-Manville. Bulletin 16

Insulating firebrick. Babcock Wilcox Co. Bulletin 162.

Wesgo super refractory shapes described in this bulletin. Wi ability to withstand almost an amount of thermal abuse, thes shapes possess high fusing range (u to 3100 deg. F.), low thermal co ductivity and complete freedo from impurities such as iron. Wes ern Gold and Platinum Works. Bu letin 526.

Steel Plant Cement for hot or col patching of soaking pits, ope hearths, electric furnaces, forgin furnaces and reheating furnaces described in new folder by Electr Refractories & Alloys Corp. Bulleti 407.

Heavy Duty Refractories. Norto Co. Bulletin 164.

FINISHING • PLATING • CLEANING

"Production Cleaning of Die Cast ings" gives the answers to a lot o surface preparation problems tha have confronted commercial pro ducers and users of die castings This informative, 12-page digest i published by Oakite Products, Inc and is available as Bulletin 619.

"Iridite", an easy-to-apply corro sion-resistant agent that unites chem ically with zinc or cadmium surfaces is described briefly in this leaflet b Rheem Research Products, Inc. In cluded is a strip of zinc-plated stee as a test sample. Bulletin 624.

Revised editions of two bulletin — No. 8, Anodizing and No. 9, Cad mium Plating — have been issued b Kelite Products, Inc. Each one out lines the practice and technique o the operations involved. Bulleti 589.

A protective, deep black finish t steel. Heatbath Corp. Bulletin 17

Cyanide zinc and bright zinc plat ing with Turco Type X, Turco Porc kleen and Turco Penetrol is describe in this 10-page booklet by Turc Products, Inc. Bulletin 495.

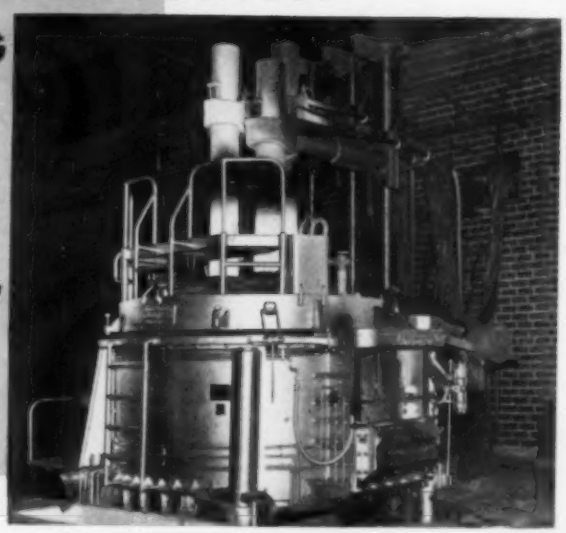
Helpful chart classifies Cowle metal cleaners for improved cleanin operations. Cowles Detergent Co Bulletin 594.

Roto-Finish equipment for de burring, buffing, polishing and colo ing. Sturgis Products Co. Bulleti 170.

Motor-Generators for electropla ing and other electrolytic processes Columbia Electric Mfg. Co. Bulleti 173.

MOORE RAPID *Lectromelt* FURNACES

PRODUCING TODAY . . . . . READY FOR TOMORROW



★ The illustrated size "OT" Lectromelt top charge type furnace, recently installed in a West Coast steel plant, is daily pouring 8 to 12 ton heats.

Because of their long efficient service with minimum maintenance, Lectromelt furnaces will be ready for the melting of quality steels and irons which will be needed in tomorrow's world at peace.

FROM 100 TONS DOWN TO 250 POUNDS CAPACITY

PITTSBURGH LECTROMELT FURNACE CORPORATION
PITTSBURGH, PENNSYLVANIA

Use Handy Coupon on Page 1336 for Ordering Helpful Literature.

Other Manufacturers' Literature Listed on pages 1338, 1340, 1342, 1346, 1354, 1356, 1358, 1360, 1362, 1364, 1368, 1370, 1372, 1374 and 1376.

Grinding Cracks AND BURNS CAN BE *Eliminated!*

Overcome these and many other common grinding troubles with the revolutionary—

QUAKER MICROGRIND PROCESS

60% REJECTS due to grinding cracks, taper and out-of-round condition . . . that was the best a large manufacturer of precision apparatus was able to obtain after 25 years of making the same part—a small ball bearing race. Both a grinding and a lapping operation were needed to secure the required finish.

Application of the Quaker MICROGRIND PROCESS not only eliminated these troubles but also produced—in a single grinding operation—the finest finish ever obtained on the part!

Equally sensational results are being obtained every day by the application of this revolutionary grinding method.

A Quaker Process Engineer will welcome the opportunity to explain—and prove to you *at our expense*—how the Quaker MICROGRIND PROCESS makes it possible to—

- **Eliminate grinding cracks.**
- **Prevent burns and distortion due to grinding.**
- **Greatly increase number of pieces ground per wheel dressing.**
- **Lengthen wheel life as much as 300%.**
- **Produce much finer, truly ground finishes.**
- **Virtually eliminate rejects.**
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- **Cut power consumption of grinders approximately 50%.**

QUAKER CHEMICAL PRODUCTS CORP.

CONSHOHOCKEN, PA.

Other Plants in CHICAGO and DETROIT Warehouse Stocks in Principal Industrial Centers

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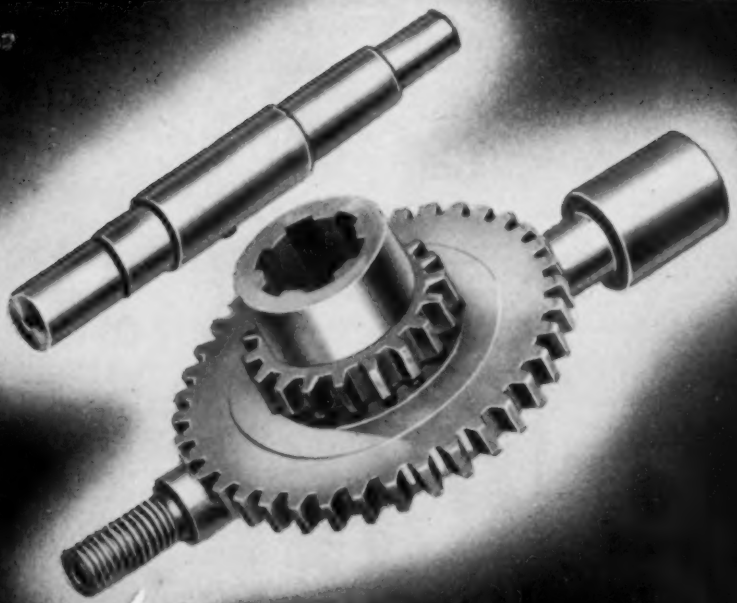
•••PLEASE PRINT COMPANY NAME AND ADDRESS IN MARGIN BELOW•••

COLD FINISHED .45+ CARBON OPEN HEARTH

SPEED TREAT STEEL



for FLAME *or*
INDUCTION HARDENING
with FAST MACHINING

USE SPEED TREAT STEEL

You will obtain hardness of 60 to 62 Rc. with water quench and of 56 to 58 Rc. with oil quench from flame or induction hardening of SPEED TREAT STEEL . . . and it machines consistently at +170 S.F.P.M.

Scores of users' plant records prove production increases of 35 to 55% — doubled tool life — elimination of breakage — scrap reductions of 50 to 75% — no warpage — and superior finishes.

SPEED TREAT ECONOMICALLY REPLACES C1043-C1046-C1137 and C1144. *USE SPEED TREAT STEEL!*

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MANUFACTURERS OF COLD FINISHED CARBON AND ALLOY STEEL BARS

WHAT'S NEW

IN MANUFACTURERS' LITERATURE

"Deoxidine" for a better rust removing and metal cleaning job is described along with several applications in this 4-page leaflet. American Chemical Paint Co. Bulletin 52

Three new booklets have been issued by the Enthone Co. describing an acid addition agent, hard drying rust-inhibiting waxes and a new alkali steel cleaner. Bulletin 420.

Alvey Ferguson Co. shows how various product washing problems were solved. Bulletin 172.

Airless Rotoblast. Pangborn Corp. Bulletin 176.

Rust inhibiting wax coatings for protection of metal. S. C. Johnson & Son, Inc. Bulletin 180.

Tumbling and cleaning. Globe Stamping and Machine Co. Bulletin 179.

Cadmium Plating. E. I. duPont deNemours & Co., Inc. Bulletin 17

Several practical data sheets show cleaning methods used on aluminum, brass and steel. Diversey Corp. Bulletin 446.

"Surface-Peening" by shot-blasting to improve the strength of metal parts is described in this leaflet by W. W. Sly Mfg. Co. Bulletin 521.

Jetal process and its characteristics as a protective coating. Alrose Chemical Co. Bulletin 213.

"Indium and Indium Plating". Indium Corp of America. Bulletin 18

Special data sheets on compounds for various cleaning jobs are offered by MacDermid, Inc. Bulletin 436.

Two informative cleaning booklets have been issued by Detrex Corporation. 16-page booklet emphasizes fundamental practices for economical use of degreasing solvents in metal cleaning departments. 8-page booklet describes alkali and emulsion cleaning compounds for all types of metal cleaning jobs. Bulletin 554.

ENGINEERING • APPLICATIONS • PARTS

Heat treating fixtures for pit-type furnaces are shown in new booklet by Driver-Harris Co. Bulletin 363.

Use Handy Coupon on Page 1338 for Ordering Helpful Literature.
Other Manufacturers' Literature Listed on pages 1338, 1340, 1342, 1346, 1354, 1356, 1358, 1360, 1362, 1364, 1366, 1370, 1372, 1374 and 1376.

THE FOOTSTEPS OF GENERAL ALLOYS MARK THE PATH OF AN INDUSTRY

GA X-ITE GA Q-ALLOYS GA X-ITE GA Q-ALLOYS

MISCELLOY

The Cleveland Metal Show, measured by the true gauge of its impetus to the war effort, was a great success. Socially, it was a "howling" success, howls coming from Detroit Fur Trappers quartered in private homes half way to Toledo, and from the marinated voyagers on the "S.S. Armpit" with one-bath-per-fifty-inmates, tied to a dock by Commodore Eisenman, just past the "nick of time" to keep the treaters from sleeping in trees.

Last year we wrote that the Show should be held to provide vitally necessary and otherwise impossible exchange of war production technology, even if visitors slept in tents.

There are a lot of guys in foxholes to whom the "S.S. Armpit" would look like the "Queen Mary", and the third rate "hustelries" seem luxurious. Of course there were some who did not want to sleep; then there was the inventor from Battelle so tired after local research that his hydraulic alarm clock went off without waking him up.

Late bulletin from Paris reveals that the filles-de-joie were hors-de-combat during the occupation. Similarly were French Labor leaders who initiated the sit-down-strike that spread to put a Michigan ex-governor on the end of the Supreme Court bench. Mademoiselle from Armentiers is now a Madame, U. S. slot machines are en route.

My friend, Baldemoro Barbara, Filho, of Rio, who was our guest in 1936, has with his brother succeeded his father as head of the famous Brazilian firm of Cia. Metallurgica Barbara ($15,000,000.00 capital), who, incidentally, pioneered centrifugal casting years before the Watertown Arsenal 25 years ago added the major American contributions and passed them on to the pipe industry, whose 1918 sewer pipe technique, patents expired, has recently permeated even the lower levels of the alloy industry. The newest technique is a Ford of Canada development.

Billie Barbara, Filho (Filho = Junior) and his associates have formed the new Brazilian firm of Sociedade de Equipamentos E Acos Barbara Ltda., and have asked us to contact top flight American equipment manufacturers who want prime Brazilian representation. If interested please write us.

If you have any doubt as to the metallurgical, i.e., service value of the average alloy casting supplied during the war, get a bid from a scrap dealer on 35-15 scrap. The current market is one-third of the ceiling price. The guys who made it are scared to death to remelt it. (They already have, again, and again, and again.)

If you did not get your copy of the $\frac{.50}{A}$ Engineer, distributed at the Cleveland Show, drop us a line.

We are still getting letters of congratulation on our 25th Anniversary, and are deeply gratified. The letters received from our friends are our most priceless possession.

Now that the election is over, the next contest that will determine your future condition of servitude is whether organized labor can get the needle into returning service men as they dribble back from the war, or, **vice versa.**

Now that you can get reasonable delivery on Q-ALLOY and X-ITE why not call in General Alloys engineer and get set now. If you got some of those "Z grade" alloy trays with your furnace—better replace them first.

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District Sales Manager
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Phone: Madison 5705

INDIANAPOLIS
Geo. O. Desautels Co.
438 Postal Station Bldg.
Phone: Riley 4411

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E. E. Whiteside
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Phone: Main 3646

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Phone: Rittenhouse 1986

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Phone: University 3887

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Phone: Marquette 0673

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Phone: Barclay 7-9031

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J. J. Donovan, Manager
224 S. Michigan Ave.
Phone: Harrison 5652

MUNCIE
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114 E. Washington St.
Phone: Muncie 840

DAYTON
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1926 Malvern Ave.
Phone: Taylor 5201

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Chew & Burke Equipment Co.
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Phone: Atlantic 7750

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Charles F. Peace
229 So. Howard St.
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LOS ANGELES
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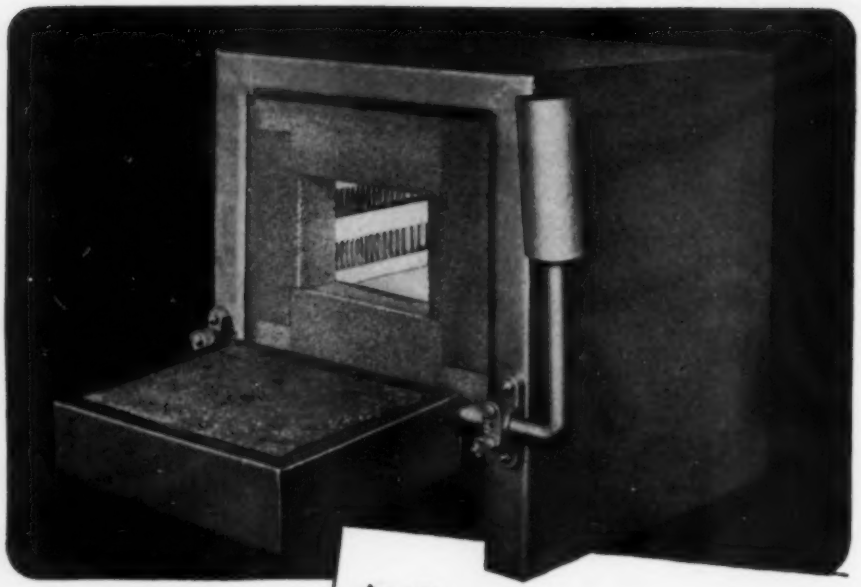

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★ Large Work Chamber
7½" W. x 5½" H. x 14" L.
to 12" W. x 9" H. x 21" L.

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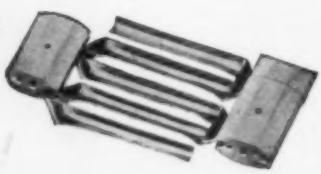
Trent's patented "Folded & Formed" ribbon elements . . . Low Watt Density . . . Low Maintenance . . . dependability proven over 25 years.



★ Brick-to-Brick Door Seal
★ Full Metal Outer Casing
★ Quick-Acting Door Lever
★ High-Temperature Insulation

WRITE TODAY FOR BULLETIN 44-TA

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HAROLD E. TRENT COMPANY

FURNACES • OVENS • HEATING ELEMENTS
LAB and SPECIAL EQUIPMENT • KETTLES

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WHAT'S NEW

IN MANUFACTURERS' LITERATURE

24-page catalog pictures and describes more than 100 custom-built metal baskets, trays, crates and fixtures designed for handling metal parts in processing. Rolock, Inc. Bulletin 622.

Heat and corrosion resistant alloy castings made by Michiana Products Corporation are discussed in Booklet 110. Details of most widely used alloys and numerous pictures are shown in this 16-page book. Bulletin 623.

Engineering data book on "Stermet" heat and corrosion resisting castings pictures many applications and discusses grades and applications for temperatures from 1000 deg. F. to 2250 deg. F. Sterling Alloys, Inc. Bulletin 626.

"Metal Quality" is the title of this 40-page booklet showing how the progressive hot working of steel in the rolling mills and with closed dies in forging hammers improves the quality and strength of the metal. Drop Forging Assn. Bulletin 610.

General booklet on B. F. Goodrich Co.'s industrial rubber products discusses devises of rubber and metal which reduce vibration, molded, extruded, lathe cut and sponge rubber products, rubber lined tanks and valves and other products. Bulletin 614.

A complete 168-page commercial catalog on powder metallurgy has been released by Chrysler Corporation's Amplex Division. It presents a wide variety of up-to-the-minute engineering developments and facts on powder metal bearings and parts. Bulletin 583.

Heat resisting alloys, cast-rolled, fabricated, and a line of heat treating equipment, are described and illustrated in this 12-page booklet. Michigan Steel Casting Co. Bulletin 584.

4-page bulletin describes and illustrates the various types of Meehanite manufactured for wear resisting applications. Meehanite Research Institute. Bulletin 585.

Weldco crates and baskets that provide extra pay load, longer service life and greater safety are described in literature by the Youngstown Welding and Engineering Co. Bulletin 598.

Use Handy Coupon on Page 1338 for Ordering Helpful Literature.

Other Manufacturers' Literature Listed on pages 1338, 1340, 1342, 1346, 1354, 1356, 1358, 1360, 1362, 1364, 1366, 1368, 1372, 1374 and 1376.

A Reminder

The following pure, carbide-free metals and alloys are made by the Thermit alumino-thermic process:

PURE MANGANESE
PURE CHROMIUM
FERRO-TITANIUM

While it is not always possible for us to supply all of these today, they will all be available without restrictions when Thermit is no longer needed for war purposes.

ETAL & THERMIT CORPORATION
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OLDSMOLOY FOR CHEMICAL EQUIPMENT

PHYSICAL CHARACTERISTICS	
Tensile Strength—psi	70,000 to 76,000
Elongation in 2"—%	15 to 20%
Reduction in area—%	21.70
Proportional Elastic Limit, with Berry Strain Gauge—psi	25,150

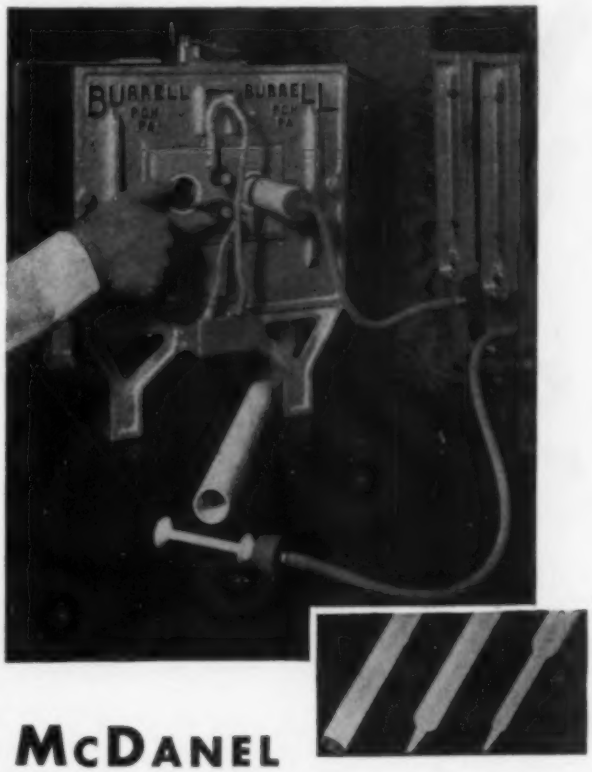
The strength and corrosion resisting qualities of Oldsmoloy—chrome-nickel-molybdenum bronze—permit its use as machine fittings and centrifugal pump parts for the handling of saline solutions, dilute sulphuric acid and other chemical solutions.

Oldsmoloy is non-magnetic, non-carbonizing. It welds readily and machines easily.

Write for Bulletin giving specifications and applications.

OLDS ALLOYS Company
8686 Rheem Ave., Southgate, Calif.
Suburb of Los Angeles

A-3



McDANEL COMBUSTION TUBES
are FIRED for High-Temperature Furnaces

McDanel high temperature tubes are a synthetic product, the result of an exclusive process in which the ingredients combine to form natural Mullite crystals when fired at temperatures in excess of 3100°F. This process gives a stronger, harder, more homogeneous structure with a low coefficient of expansion and high resistance to thermal shock.

McDanel high temperature combustion tubes are:

- Dense, vitreous, and gas-tight
- Straight and accurately sized
- Smooth inside, easily cleaned
- Free from devitrefication
- Not distorted at high temperatures
- Unconditionally guaranteed to withstand temperatures up to 2900°F., thus providing a wide margin of safety when used in Burrell Furnaces where temperatures up to 2650°F. are recommended.

For complete information on McDanel high temperature combustion tubes write for Burrell High Temperature Furnace Catalog, F-241.

BURRELL
TECHNICAL SUPPLY COMPANY
1936-42 Fifth Avenue Pittsburgh (19), Pa.

3 REASONS WHY WELDCO PICKLING CRATES AND BASKETS

Save Money for you

GREATER PAY LOAD . . . Welded into one solid piece, made of lighter weight wrought sections that have greater strength per pound, WELDCO crates and baskets carry more parts per load with greater safety.

LONGER LIFE . . . Made of corrosion resistant material . . . Monel, Inconel, and stainless steel, and welded into virtually one piece, WELDCO crates and baskets offer longer service than any other make made with any other material or made in any other way.

SPECIAL DESIGN . . . to meet your special requirements. Specialists for years in designing pickling equipment, WELDCO's large engineering staff will design special equipment which will best meet your production needs.

THE YOUNGSTOWN WELDING & ENGINEERING CO.

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Mail me your catalog

Company Name_____

Your Name_____ Title_____

City_____ State_____

WHAT'S NEW

IN MANUFACTURERS' LITERAT

Illustrated literature describes tails and advantages of Elastic Nuts. Elastic Stop Nut Corp. letin 595.

Pressed steel pots are describe Bell & Gossett Co. in new Bul 364.

Specifications and physical p erties of bronze and aluminum a are shown in Olds Alloys Co. l tin 457.

24-page catalog is guide to pro ties and use of Monsanto pla Monsanto Chemical Co. Bulletin

Carburizing Boxes. Pressed Co. Bulletin 193.

Chace manganese alloy No. 7 sheets, strips, rod and special s described by W. M. Chace Co. letin 190.

Catalog gives complete spec tion data on Bunting bearings bars. Bunting Brass & Bronz Bulletin 343.

16-page booklet gives engine standards and technical inform on "AERO-THREAD" screw th system. Well-illustrated and he booklet by Aircraft Screw Pro Co., Inc. Bulletin 567.

Illustrated leaflet presents data uses of special alloys resisting rosion, high temperatures and sion. The Duraloy Co. Bulletin

Three-color chart of decimal e alents. John Hassall, Inc. Bul 458.

Drop, hammer and upset forg Kropp Forge Co. Bulletin 534.

Steel Forgings. Transue and liams Steel Forging Co. Bulletin

Heat and corrosion resistant ings as engineered by Alloy Ca Company are described along plant facilities in an interestin page booklet. Bulletin 557.

Complete line of Mallory r electrical and electronic parts, sizes, dimensions and rated c ities is described in new 36 booklet. P. R. Mallory & Co., Bulletin 448.

Handsome 12-page brochure tures the cast steel breech ring their advantages as produced b Ohio Steel Foundry Co. Bulletin

Use Handy Coupon on Page 133 for Ordering Helpful Literature Other Manufacturers' Literature L on pages 1338, 1340, 1342, 1346, 1354 1358, 1360, 1362, 1364, 1366, 1368, 1374 and 1376.

DILLON

PRECISION DYNAMOMETER

INDICATE TENSION DIRECT IN POUNDS!

9 capacities from 0-500 lbs. up to 0-20,000 lbs.

Weigh only 8 lbs. 4 oz., measure 8¼" x 6¼" x 3"

An ideal laboratory or field instrument for indicating tension or stress in cable, rope, castings, assemblies, many other mechanical setups. Thousands in use by leading plants. Fits into "tight" spots easily. Not injured by accidental overload. Has safety glass cover and maximum hand. PRICED LOW. Immediate shipment.

WRITE FOR INTERESTING BULLETINS

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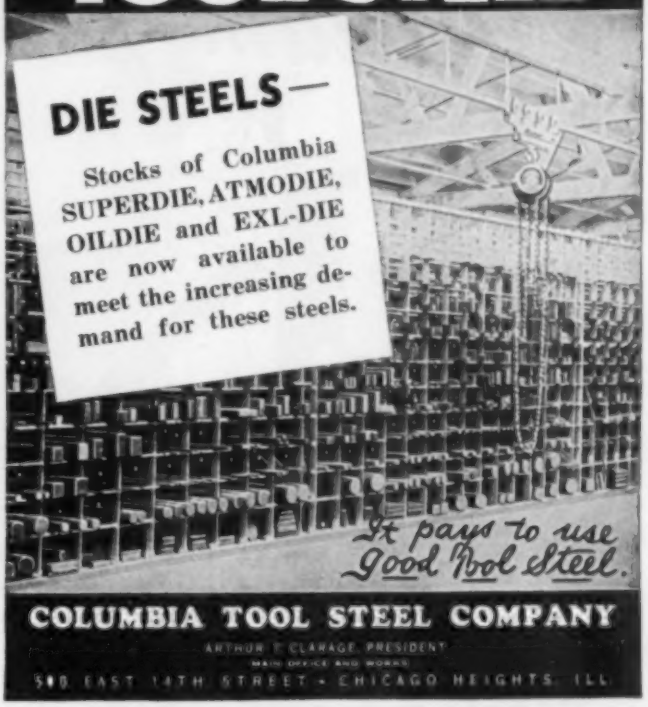
Columbia TOOL STEEL



DIE STEELS—

Stocks of Columbia SUPERDIE, ATMODIE, OILDIE and EXL-DIE are now available to meet the increasing demand for these steels.

It pays to use Good Tool Steel.

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WHY MANUFACTURERS PREFER ROTARY GAS TEMPERING MACHINES

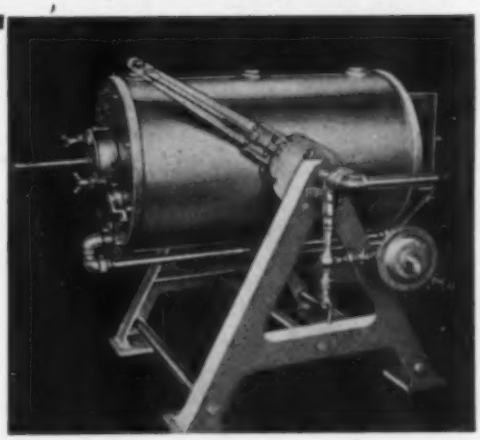
For all parts which may be gently tumbled, there is no surer way of obtaining uniformity in tempering than by the use of AGF Rotary Gas Tempering Machines.

The slow rotation prevents the pieces being tempered from resting or lying flat on each other. Heating of the work is exceptionally rapid and far more uniform than can be obtained in a stationary furnace, either with or without convective circulation.

The construction of the machines is such that they may be used for temperatures up to 1000°F. Any specific temper color may be readily obtained.

Where desired, Rotary Gas Tempering Machines permit tempering and blackening to be combined in one operation, thus eliminating one step in the production processes of many articles with a consequent reduction in the cost of manufacture. The resulting black Carbonia Finish* is rust resistant to a high degree, may be polished, and will not chip, spall, or flake off.

Typical parts which may be simultaneously tempered and Carbonia* blackened are cap screws, chain links, parts for fire arms, buckles, and similar articles.



Illustrated—No. 64 Rotary Gas Tempering Machine, one of four standard models. Write for Bulletin No. 805, giving complete details.

*Carbonia Finish is the original "gun metal finish" introduced by the American Gas Furnace Co., and proven through 35 years' successful use.

AMERICAN GAS FURNACE CO.

ELIZABETH, NEW JERSEY.

how to buy...
a cutting fluid

• "It's hard to tell the depth of a well by the length of the handle on the pump"... and it's even harder to tell the real worth of a cutting fluid by appearances alone.

For instance:

Lower viscosity does not necessarily mean more effectiveness at the work area.

Dark oils are often cleaner than light-colored, clear-looking oils.

More total sulphur does not always mean better cutting quality.

Straight oils are often better refrigerants at the point of contact than soluble products.

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The wise buyer measures cutting fluids by how they perform on the machine. To find the best performing oil for his needs, he looks to experience.

D. A. Stuart Oil Co., specialists in industrial oils since 1865, share their experience with thousands of such wise buyers. They stand ready to do the same for you.

WRITE FOR YOUR COPY

of the *New* Stuart 60 page handbook: "Cutting Fluids For Better Machining." It is full of data—information that you will find a helpful guide to the most efficient use of cutting fluids. It is free to executives and engineers.

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Warehouses in Principal Metal-Working Centers

WHAT'S NEW

IN MANUFACTURERS' LITERATURE

Cr-Ni-Mo Steels. A Finkl & Sons Co. Bulletin 203.

"Mechanical Springs, Their Engineering and Design" is the title of a 106-page handbook just issued jointly by the divisions of Associated Spring Corporation. Bulletin 481.

Many types of heat treating and pickling baskets and containers are shown in new booklet by the Stanwood Corp. Bulletin 445.

Specifications and diagrams are included in description of welded rings and bands. American Welding & Mfg. Co. Bulletin 536.

New 32-page illustrated booklet contains much data on manganese steel for the railroad industry. American Manganese Steel Div. Bulletin 388.

New information sheets on tapered and formed tubes have just been issued by Summerill Tubing Co. Bulletin 369.

54-page booklet, "File 41—Engineering Data Sheets", gives complete facts on Ampco Metal's physical properties and service record. Bulletin 368.

Electrical, corrosion and heat resisting alloys in rod, wire, ribbon and strip forms. Wilbur B. Driver Co. Bulletin 192.

Reference data book entitled "The Improvement of Metals by Forging" has been issued by Steel Improvement & Forge Co. Bulletin 409.

Interesting and informative literature on "Pomet" powder metallurgy products. Powder Metallurgy Corp. Bulletin 454.

X-Ray Inspected Castings. Electro Alloys Co. Bulletin 197.

Steel Castings. Chicago Steel Foundry Co. Bulletin 199.

Heat Resisting Alloys. General Alloys Co. Bulletin 200.

The Wilco Blue Book deals with the 29 Wilco Thermometals, their properties, functions, applications and temperature ranges. H. A. Wilson Co. Bulletin 531.

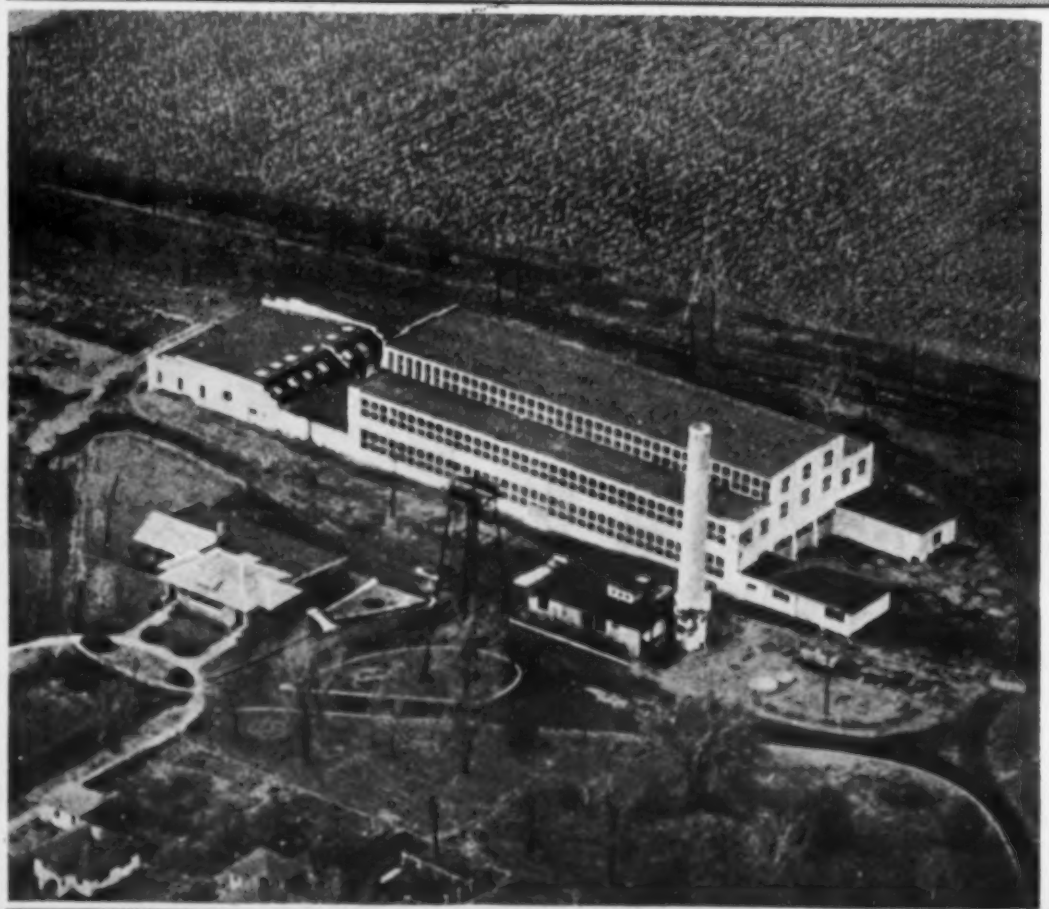
Illustrated leaflet describes stainless steel castings by Atlas Foundry Co. Bulletin 437.

Use Handy Coupon on Page 1338 for Ordering Helpful Literature.

Other Manufacturers' Literature Listed on pages 1338, 1340, 1342, 1346, 1354, 1356, 1358, 1360, 1362, 1364, 1366, 1368, 1370, 1372 and 1376.

If You Use Heat Resistant Alloys in Your Heat Treat

Mail The Coupon Now



No better Alloy Plant than this 11 acre plant layout exists anywhere.

If You Visited The National Metal Congress At Chicago You Observed The Superiority Of ACC And Engineering ACCOLOY Castings By Direct Comparison. If You Use Heat Resistant Alloy Casting Or Furnace Parts, You'll Be Interested In This Unusual Booklet Of Which So Many People Have Requested Extra Copies.

ACC

ALLOY CASTING COMPANY

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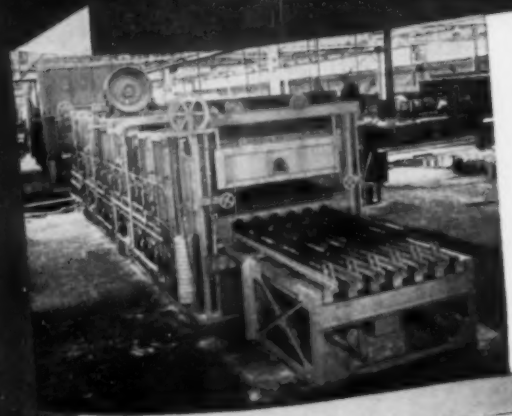
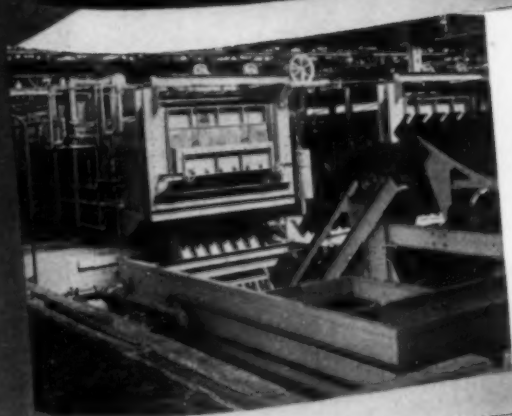
It Takes the Best to Make the Best

Prepare

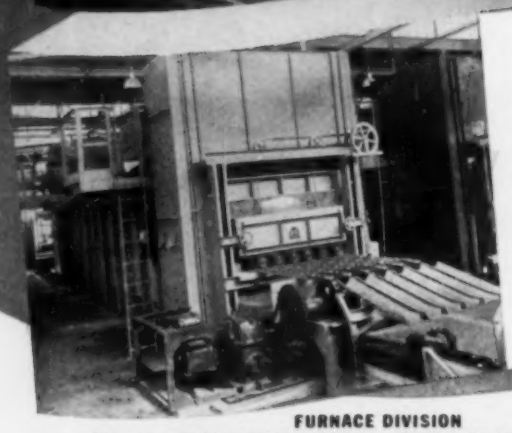
for Post-War Production with R-S Continuous Furnaces



Unexcelled engineering ability in the production of heat-treated heavy artillery shells is exemplified by this automatic, gas-fired R-S installation. The shells are pushed through the hardening furnaces in six parallel conveying tubes.



Shells are quenched internally and externally, then leave the quench tanks on continuous conveyors.



The draw furnaces, through which the shells move on alloy chains. The result is uniform heat-treatment and low cost production.

FURNACE DIVISION

R-S PRODUCTS CORPORATION

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R-S Furnaces of Distinction

PLATE AND ANGLE HEATING

ANNEALING CONVECTION CAR HEARTH ROTARY HEARTH

CONTINUOUS CONVEYOR SALT BATH FORGING METAL MELTING

Buy War Bonds

WHAT'S NEW

IN MANUFACTURERS' LITERATURE

MELTING • CASTING • MILL OPERATIONS

6 special advantages of conveyor type foundry ovens offered by Despatch Oven Co. are presented in this illustrated 4-page leaflet. Bulletin 617.

Melting of soft metals in Surface Combustion furnaces is described in this illustrated leaflet. Bulletin 606.

Crucible melting furnaces, stationary and tilting types, oil or gas fired, are described in this leaflet by W. S. Rockwell Co. Bulletin 609.

Ingot Production. Gathmann Engineering Co. Bulletin 185.

New Tercod Crucible Catalog tells how to achieve faster melting, lower costs per casting, conserve fuel and solve many other important, current problems. Electro Refractories and Alloys Corp. Bulletin 574.

Electric Furnaces. Detroit Electric Furnace Div., Kuhlman Electric Co. Bulletin 189.

This ring-binder presents 24 pages on the use and effect of Titanium in steel and cast irons. Titanium Alloy Mfg. Co. Bulletin 470.

52-page booklet describes Moore rapid Lectromelt furnaces for iron, steel, nickel and copper melting and refining. Pittsburgh Lectromelt Furnace Corp. Bulletin 404.

"Electromet Products and Service". Electro Metallurgical Co. Bulletin 186.

Interesting and helpful information available on the use of alloy pots for heating operation by the Swedish Crucible Steel Co. Bulletin 137.

Operating Features, capacities, charging methods of the Heroult electric furnace. American Bridge Co. Bulletin 215.

Attractive booklet describes growth, facilities and offers valuable alloy hints. Niagara Falls Smelting & Refining Corp. Bulletin 246.

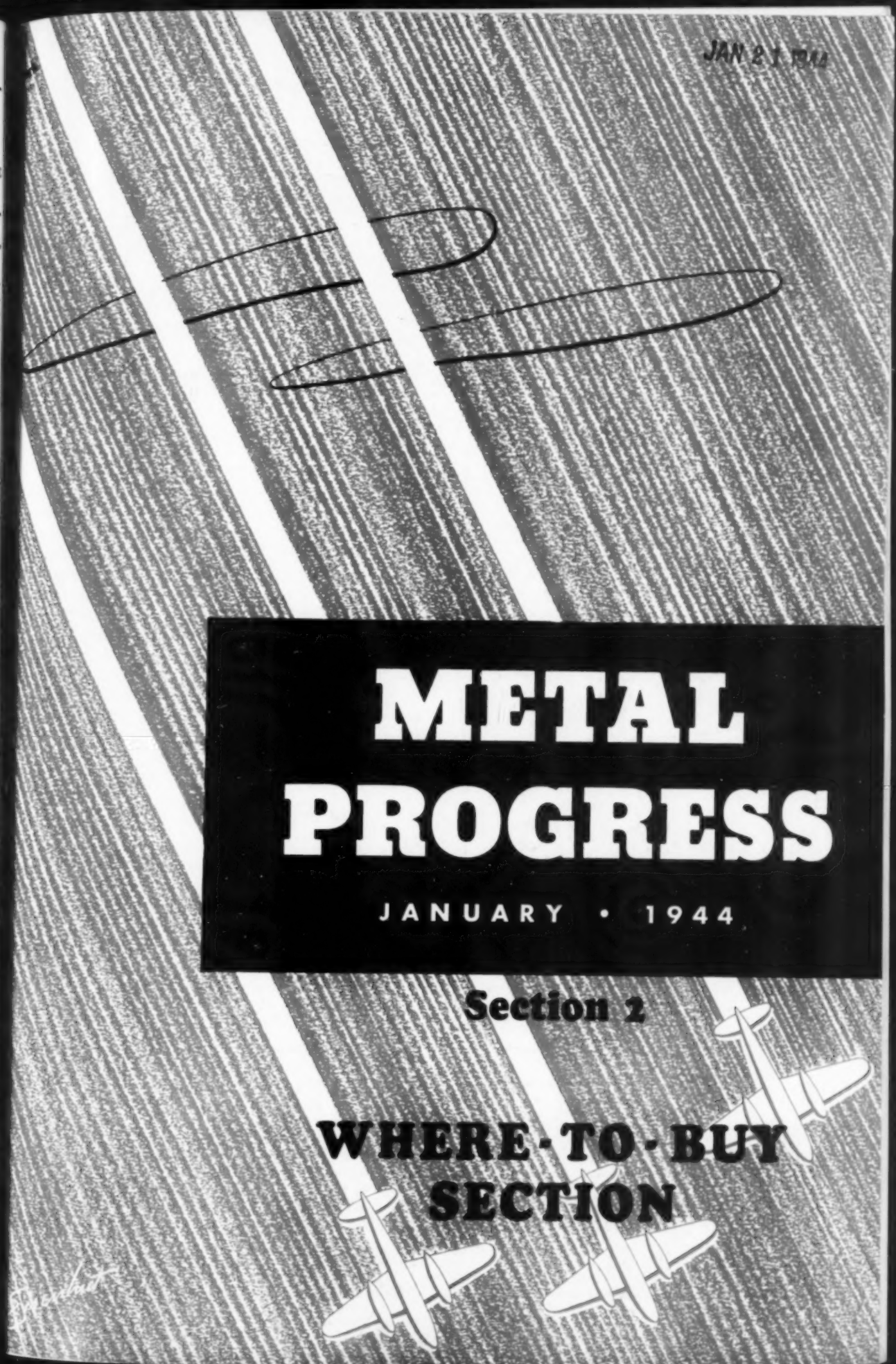
GENERAL

New leaflet describes interoffice communication system offered by Executone Communication Systems. Bulletin 385.

Use Handy Coupon on Page 1338 for Ordering Helpful Literature.

Other Manufacturers' Literature Listed on pages 1338, 1340, 1342, 1346, 1354, 1356, 1358, 1360, 1362, 1364, 1366, 1368, 1370, 1372 and 1374.

JAN 21 1944



METAL PROGRESS

JANUARY • 1944

Section 2

WHERE-TO-BUY SECTION

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Original reverse current process and especially formulated compounds for faster, more exacting electro-cleaning.

METEX

Individually developed, hard hitting compounds for cleaning metals and alloys. Available in special variations for war requirements.

SOLVMAX and SOLVTEX

Water and spirit emulsion cleaners for high pressure and rotary washing machine operations.

METALEX

Fast, positive compounds for cleaning in tumbling barrels and some types of rotary washers. Easy to use and economical.

DURODEX

Superior formulations for electro-cleaning where excessive dragout makes price economy essential.

INHIBITEX

#2 For sure removal of rust and scale in heavy duty pickling.
#1 Penetrates closely nested parts through powerful wetting action—speedily removes oily scale.

CHOOSE THE COMPOUND *for Your* CLEANING PROBLEMS

No matter what your product is or what equipment you have for cleaning before plating, coating or finishing . . . if it is made of metal MAC DERMID INCORPORATED has a compound developed for your requirements that is guaranteed to speed up production, improve the luster of your product and reduce your operating costs. This perfection is made possible through a concentrated effort on the part of MAC DERMID INCORPORATED chemists and service engineers who have for over twenty years directed all their efforts toward being of greater service to the metal finishing industry.

Determine Your Requirements Now for Post War Production

Don't wait until the whistle blows! A MAC DERMID INCORPORATED service engineer will be pleased to help you with your post war planning now; show you the new, faster acting compounds that have been developed for modern production; help you organize your metal finishing room for greater efficiency; place your order for any equipment that you may need . . . Write us for our informative, new folders and special data sheets on any metal cleaning compound. You will find our products and equipment listed under more than forty different classifications in this directory.

Compounds and Equipment for Every Metal Cleaning Problem

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NEW YORK	DETROIT	CHICAGO	LOS ANGELES	CLEVELAND	ST. LOUIS	TORONTO—CAN.
Udylite Corp. (L. I. City)	Udylite Corp. Wagner Bro.	Udylite Corp. Geo. A. Stutz Mfg. Co.	Nobs Chemical Co.	Udylite Corp. McGean Chem. Co	LaSalco, Incorporated	Clark Industrial Supplies Co.

WHERE-TO-BUY

ASIVE CLOTH, GRAIN, PAPER [1]
Buehler, Chicago, Ill.
ell Technical Supply Co., Pittsburgh
orundum Co., Niagara Falls, N. Y.
r & Amend, New York
r Scientific Co., Pittsburgh
esota Mining & Mfg. Co., St. Paul
anto Chemical Co., St. Louis, Mo.
n Co., Worcester, Mass.

ASIVE CUTTING MACHINES [2]
Buehler, Chicago, Ill.
ew C. Campbell Div., A. C. & C. Co.,
. Bridgeport, Conn.
lenge Machy. Co., Grand Haven, Mich.
innati Elec. Tool Co., Cincinnati, O.
er Mfg. Co., St. Louis
DeSanno & Son, Phoenixville, Pa.
lt Products Corp., Lancaster, Pa.
r Mfg. Co., Philadelphia

ASIVE POWDERS [3]
rican Optical Co., Southbridge, Mass.
ch & Lomb Opt. Co., Rochester, N. Y.
Buehler, Chicago, Ill.
orundum Co., Niagara Falls, N. Y.
du Pont de Nemours & Co., Inc.,
lmington, Dela.
rson & Co., Haverhill, Mass.
s-Manville, New York
Instrument Co., Cambridge, Mass.
anto Chemical Co., St. Louis, Mo.
n Co., Worcester, Mass.
burgh Crushed Steel Co., Pittsburgh

ASIVES—Steel Shot and Grit [4]
r. Fdry Equip. Co., Mishawaka, Ind.
orundum Co., Niagara Falls, N. Y.
tach Engr. Corp., Yonkers, N. Y.
e Steel Abrasive Co., Mansfield, Ohio
erick Gumm Chem. Co., Kearny, N. J.
rson Abrasive Corp., Manchester, N. H.
Dermid, Inc., Waterbury, Conn.
onal Metal Abrasive Co., Cleveland
born Corp., Hagerstown, Md.
ons Engr. Corp., Cleveland, Ohio
sylvania Foundry Supply & Sand Co.,
iladelphia, Pa.
burgh Crushed Steel Co., Pittsburgh
W. Sly Mfg. Co., Cleveland, Ohio
n Engineering Co., Inc., Warren, Ohio
tehead Bros. Co., New York, N. Y.

ASIVE WHEELS—See Grinding Wheels

ETYLENE—In Cylinders [5]
ylene Gas Co., St. Louis, Mo.
Reduction, New York
e Air Products Co., New York
onal Cylinder Gas Co., Chicago

LESS BLAST CLEANING [6]
r. Fdry Equip. Co., Mishawaka, Ind.
trifugal Cast. Mach. Co., Tulsa, Okla.
onal Metal Abrasive Co., Cleveland
born Corp., Hagerstown, Md.
W. Sly Mfg. Co., Cleveland, Ohio

LOY STEELS—See Steel—Alloy

LOYS—Aluminum [7]
minum Co. of America, Pittsburgh, Pa.
x Smelting Co., Chicago
e Mineral Co., Philadelphia
ntier Bronze Corp., Niagara Falls, N. Y.
ara Falls Smelting & Refining Corp.,
ffalo, N. Y.
e Reducing Corp., Wallington, N. J.
tehead Metal Products Co., New York

LOYS—Corrosion Resistant [8]
x Metal Co., Philadelphia
egheny Ludlum Steel Corp., Brackenridge, Pa.
oy Casting Co., Champaign, Ill.
minum Co. of America, Pittsburgh, Pa.
minum Industries, Inc., Cincinnati
erican Brass Co., Waterbury, Conn.
er. Mang. Bronze Co., Philadelphia
er. Mang. Steel Div., American Brake Shoe Co., Chicago Hts.
er. Steel & Wire Co., Cleveland, Ohio
poo Metal, Inc., Milwaukee, Wis.
ls-McCarthy & Rogers, Inc., Buffalo
hlehem Steel Co., Bethlehem, Pa.
dgeport Brass Co., Bridgeport, Conn.
wn-Wales Co., Boston, Mass.
ting Brass & Bronze Co., Toledo, Ohio
rgess-Parr Co., Freeport, Ill.
Callite Tungsten Corp., Union City, N. J.
G. O. Carlson, Inc., Thorndale, Pa.
Carnegie-Illinois Steel Corp., Pgh., Pa.
Carpenter Steel Co., Reading, Pa.
Chase Brass & Cop. Co., Waterbury, Conn.
Chicago Steel Foundry Co., Chicago, Ill.
Columbia Steel Co., San Francisco, Calif.
Cooper Alloy Foundry Co., Hillside, N. J.
Copperweld Steel Co., Warren, Ohio
Driver-Harris Co., Harrison, N. J.
Wilbur B. Driver Co., Newark, N. J.
Duraloy Co., Scottdale, Pa.
Duriron Co., Inc., Dayton, O.
Edgcomb Steel Corp., Hillside, N. J.
Electro Alloys Company, Elyria, Ohio
Electro Metallurgical Co., New York
Empire Steel Castings, Inc., Reading, Pa.
Fahralloy Co., Harvey, Ill.
Firth-Sterling Steel Co., McKeesport, Pa.
Peter A. Frasse & Co., Inc., New York
General Alloys Co., Boston, Mass.
Hammond Brass Works, Hammond, Ind.
Haynes Stellite Co., Kokomo, Ind.
Hoskins Mfg. Co., Detroit, Mich.
Indium Corp. of America, New York
Industrial Steels, Inc., Cambridge, Mass.
Ingersoll Steel & Disc, Chicago
Inland Steel Co., Chicago
International Nickel Co., New York
Joslyn Mfg. & Supply Co., Ft. Wayne, Ind.
Latrobe Electric Steel Co., Latrobe, Pa.
Lebanon Steel Foundry, Lebanon, Pa.
Lukens Steel Co., Coatesville, Pa.
McCauley Alloy Co., Chicago Hts., Ill.
Michiana Prod. Corp., Michigan City, Ind.
Michigan Steel Casting Co., Detroit
Midvale Co., Philadelphia
Mueller Brass Co., Port Huron, Mich.
National Tube Co., Pittsburgh, Pa.
Nicralumin Co., Wilmington, Delaware
Ohio Steel Foundry Co., Springfield, O.
Permo Products Corp., Chicago
Pittsburgh Steel Co., Pittsburgh, Pa.
Horace T. Potts Co., Philadelphia, Pa.
Republic Steel Corp., Cleveland, Ohio
Revere Copper & Brass Co., New York
Reynolds Metals Co., Louisville, Ky.
Rustless Iron & Steel Corp., Balt., Md.
Jos. T. Ryerson & Son, Inc., Chicago
Sterling Alloys Co., Woburn, Mass.
Sivyer Steel Castings Co., Milwaukee, Wis.
Summerill Tubing Co., Bridgeport, Pa.
Superior Steel Corp., Carnegie, Pa.
Taylor-Wharton Iron & Steel Co., High Bridge, N. J.
Tenn. Coal, Iron & R. R. Co., Birm., Ala.
Titan Metal Mfg. Co., Bellefonte, Pa.
Tube Reducing Corp., Wallington, N. J.
Tubular Alloy Steel Corp., Gary, Ind.
U. S. Steel Supply Co., Chicago
Vanadium-Alloys Steel Co., Latrobe, Pa.
Wall-Colmonoy Corp., Detroit
Whitehead Metal Products Co., New York
Williams & Co., Pittsburgh
Worthington Pump & Machinery Corp., Harrison, N. J.
Youngstown Sheet & Tube Co., Youngstown, O.

ALLOYS—Ferro—See Ferro Alloys

ALLOYS—Heat Resistant [9]
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Alloy Casting Co., Champaign, Ill.
Alten's F'dry & Mach. Wks., Lancaster, O.
Aluminum Industries, Inc., Cincinnati
American Brass Co., Waterbury, Conn.
Amer. Mang. Steel Div., American Brake Shoe Co., Chicago Hts.
Amer. Steel & Wire Co., Cleveland, Ohio
Beals-McCarthy & Rogers, Inc., Buffalo
Bethlehem Steel Co., Bethlehem, Pa.
Binney Castings Co., Toledo
Blaw-Knox Co., Pittsburgh, Pa.
Brown-Wales Co., Boston, Mass.
Burgess-Parr Co., Freeport, Ill.
A. M. Byers Co., Pittsburgh
Calorizing Co., Pittsburgh, Pa.
G. O. Carlson, Inc., Thorndale, Pa.
Carnegie-Illinois Steel Corp., Pgh., Pa.
Carpenter Steel Co., Reading, Pa.
Chicago Steel Foundry Co., Chicago, Ill.
Columbia Steel Co., San Francisco, Calif.
Cooper Alloy Foundry Co., Hillside, N. J.
Copperweld Steel Co., Warren, Ohio
Driver-Harris Co., Harrison, N. J.
Wilbur B. Driver Co., Newark, N. J.
Duraloy Co., Scottdale, Pa.
Duriron Co., Inc., Dayton, O.
Edgcomb Steel Corp., Hillside, N. J.
Ekstrand & Tholand, Inc., New York
Electro Alloys Company, Elyria, Ohio
Empire Steel Castings, Inc., Reading, Pa.
Fahralloy Co., Harvey, Ill.
Firth-Sterling Steel Co., McKeesport, Pa.
Peter A. Frasse & Co., Inc., New York
General Alloys Co., Boston, Mass.
Haynes Stellite Co., Kokomo, Ind.
Hoskins Mfg. Co., Detroit, Mich.
Ingersoll Steel & Disc, Chicago
International Nickel Co., New York
Joslyn Mfg. & Supply Co., Ft. Wayne, Ind.
Lebanon Steel Foundry, Lebanon, Pa.
Lehigh Steel Co., New York
Mahr Mfg. Co., Minneapolis, Minn.
Michiana Prod. Corp., Michigan City, Ind.
Michigan Steel Casting Co., Detroit
Midvale Co., Nicetown, Philadelphia, Pa.
National Tube Co., Pittsburgh, Pa.
Nitralloy Corp., New York
Ohio Steel Foundry Co., Springfield, O.
Horace T. Potts Co., Philadelphia, Pa.
Republic Steel Corp., Cleveland, Ohio
Arklay S. Richards Co., Inc., Newton Highlands, Mass.
Rustless Iron & Steel Corp., Balt., Md.
Jos. T. Ryerson & Son, Inc., Chicago
Sivyer Steel Castings Co., Milwaukee, Wis.
Standard Alloy Co., Cleveland
Sterling Alloys Co., Woburn, Mass.
Superior Steel Corp., Carnegie, Pa.
Tenn. Coal, Iron & R. R. Co., Birm., Ala.
Tube Reducing Corp., Wallington, N. J.
Tubular Alloy Steel Corp., Gary, Ind.
Wall-Colmonoy Corp., Detroit
Whitehead Metal Products Co., New York
Williams & Co., Pittsburgh

ALLOYS—Nonferrous [10]
Ajax Metal Co., Philadelphia
Aluminum Co. of America, Pittsburgh, Pa.
Aluminum Industries, Inc., Cincinnati
American Brass Co., Waterbury, Conn.
Ampco Metal, Inc., Milwaukee, Wis.
Anaconda Copper Mining Co., New York
Apex Smelting Co., Chicago
Beals-McCarthy & Rogers, Inc., Buffalo
Bearium Metals Corp., Rochester, N. Y.
Bohn Aluminum & Brass Corp., Detroit
Bridgeport Brass Co., Bridgeport, Conn.
Bunting Brass & Bronze Co., Toledo, O.
A. W. Cadman Mfg. Co., Pittsburgh, Pa.
Callite Tungsten Corp., Union City, N. J.
Carpenter Steel Co., Reading, Pa.
Chase Brass & Cop. Co., Waterbury, Conn.
Delloy Metals, Philadelphia, Pa.
Wilbur B. Driver Co., Newark, N. J.
Duquesne Smelting Corp., Pittsburgh
Eagle-Picher Sales Co., Cincinnati, O.
Electro Metallurgical Co., New York, N. Y.
Electro Ref. & Alloys Corp., Buffalo
Frontier Bronze Corp., Niagara Falls, N. Y.
Hammond Brass Works, Hammond, Ind.
Handy & Harman, New York
Haynes Stellite Co., Kokomo, Ind.
Indium Corp. of America, New York
International Nickel Co., Inc., N. Y. City
Johnson Bronze Co., New Castle, Pa.
P. R. Mallory & Co., Indianapolis, Ind.
Metal & Thermit Corp., New York
Metallurgical Products Co., Philadelphia
Mueller Brass Co., Port Huron, Michigan
National Bearing Metals Corp., St. Louis
Nat'l Bronze & Alum. Fdry. Co., Cleve., O.
National Lead Co., New York
New Jersey Zinc Co., New York
Niagara Falls Smelting & Ref. Co., Buffalo
Horace T. Potts Co., Philadelphia, Pa.
Revere Copper & Brass, Inc., New York
Reynolds Metals Co., Louisville, Ky.
Riverside Metal Co., Riverside, N. J.
Titan Metal Mfg. Co., Bellefonte, Pa.
Titanium Alloy Mfg. Co., Niag. Falls, N. Y
Tri-Clover Machine Co., Kenosha, Wis.
Tube Reducing Corp., Wallington, N. J.
U. S. Reduction Co., E. Chicago, Ind.
U. S. Steel Supply Co., Chicago
Vascoloy-Ramet Corp., N. Chicago, Ill.
Wall-Colmonoy Corp., Detroit, Mich.
Western Cartridge Co., East Alton, Ill.

ee Advertisement of Companies in Bold-Face Type for Further Information

Westinghouse Elec. & Mfg. Co., E. Pgh.
Whitehead Metal Products Co., New York

ALLOYS—Precious Metal [11]
Baker & Co., Newark, N. J.
C. S. Brainin Div., New York
Callite Tungsten Corp., Union City, N. J.
Thomas J. Dee & Co., Chicago
Firth-Sterling Steel Co., McKeesport, Pa.
Handy & Harman, New York
Indium Corp. of America, New York
International Nickel Co., New York
P. R. Mallory & Co., Inc., Indianapolis
J. M. Ney Co., Hartford, Conn.
Permo Products Corp., Chicago
Taylor-Wharton Iron & Steel Co., Easton, Pa.
H. A. Wilson Co., Newark, N. J.

ALLOY WELDING RODS—See Rods—Welding

ALUMINA—Fused Grain [12]
Aluminum Co. of America, Pittsburgh
Adolph I. Buehler, Chicago, Ill.
Burrell Technical Supply Co., Pittsburgh
Carborundum Co., Niagara Falls, N. Y.
Eimer & Amend, New York
Fisher Scientific Co., Pittsburgh
Foote Mineral Co., Philadelphia, Pa.
Norton Co., Worcester, Mass.

ALUMINUM [13]
Aluminum Co. of America, Pittsburgh, Pa.
Apex Smelting Co., Chicago
Bohn Aluminum & Brass Corp., Detroit
Fairmont Aluminum Co., Fairmont, W. Va.
Frontier Bronze Corp., Niagara Falls, N. Y.
Metallurgical Products Co., Philadelphia
Nat'l Bronze & Alum. Fdry. Co., Cleve., O.
National Smelting Co., Cleveland
Niagara Falls Smelting & Ref. Co., Buffalo
Nicralumin Co., Wilmington, Delaware
Reynolds Metals Co., Louisville, Ky.
Stephens-Adamson Mfg. Co., Aurora, Ill.
U. S. Reduction Co., E. Chicago, Ind.
Whitehead Metal Products Co., New York
Williams & Co., Pittsburgh

ALUMINUM BRONZE [14]
Ajax Metal Co., Philadelphia
American Brass Co., Waterbury, Conn.
American Mang. Bronze Co., Philadelphia
Ampco Metal, Inc., Milwaukee, Wis.
Aurora Metal Co., Aurora, Ill.
Bohn Aluminum & Brass Corp., Detroit
Chase Brass & Cop. Co., Waterbury, Conn.
Duquesne Smelting Corp., Pittsburgh
Frontier Bronze Corp., Niag. Falls, N. Y.
Hammond Brass Works, Hammond, Ind.
Koppers Co., Bartlett Hayward Div., Baltimore, Md.
Lumen Bearing Co., Buffalo
Metallurgical Products Co., Philadelphia
Mueller Brass Co., Port Huron, Mich.
Niagara Falls Smelting & Ref. Co., Buffalo
Revere Copper & Brass, Inc., New York
Western Cartridge Co., East Alton, Ill.

ALUMINUM POWDERS [15]
Aluminum Co. of America, Pittsburgh, Pa.
Aluminum Industries, Inc., Cincinnati, O.
Apex Smelting Co., Chicago
Ekstrand & Tholand, Inc., New York
Charles Hardy, Inc., New York
Metals Disintegrating Co., Elizabeth, N. J.
Powder Metals & Alloys, Inc., New York
Reynolds Metals Co., Louisville, Ky.

ALUM. WELDING RODS & FLUX [16]
Air Reduction, New York
Aladdin Rod & Flux Mfg. Co., Grand Rapids, Mich.
Allied Weld-craft, Inc., Indianapolis, Ind.
Aluminum Co. of America, Pittsburgh, Pa.
Chicago Hdw. F'dry Co., N. Chicago, Ill.
Eutectic Welding Alloys, Inc., New York
Foote Mineral Co., Philadelphia, Pa.
Krembs & Co., Chicago
Lincoln Electric Co., Cleveland
Linde Air Products Co., New York
National Cylinder Gas Co., Chicago, Ill.
Universal Power Corp., Cleveland
Whitehead Metal Products Co., New York

AMMONIA—Anhydrous [17]
Armour & Co., Chicago, Ill.
E. I. du Pont de Nemours & Co., Wilmington, Del.
Mathieson Alkali Works, Inc., New York
Monsanto Chemical Co., Merrimac Div., Everett, Mass.
Pennsylvania Salt Mfg. Co., Philadelphia

ANNEALING FURNACES—See Furnaces

ANNEALING BOXES [18]
Alloy Casting Co., Champaign, Ill.
Alloy Mfg. Co., Inc., Pittsburgh, Pa.
Amer. Mang. Steel Div., American Brake Shoe Co., Chicago Hts.
Bell & Gossett Co., Chicago, Ill.
Blaw-Knox Co., Pittsburgh, Pa.
Carnegie-Illinois Steel Corp., Pittsburgh
Case Hardening Service Co., Cleveland
Chicago Steel Foundry Co., Chicago, Ill.
Continental Roll & Steel Fdy. Co., East Chicago, Ind.
Driver-Harris Co., Harrison, N. J.
Duraloy Co., Scottdale, Pa.
Eclipse Fuel Eng'ring Co., Rockford, Ill.
Electric Furnace Co., Salem, Ohio
Electro Alloys Co., Elyria, O.
Fahralloy Co., Harvey, Ill.
General Alloys Co., Boston, Mass.
A. F. Holden Co., New Haven, Conn.
Hoskins Mfg. Co., Detroit, Mich.
Lake City Malleable Co., Cleveland, Ohio
Meehanite Research Institute, Pgh., Pa.
Michiana Prod. Corp., Michigan City, Ind.
Michigan Steel Cstg. Co., Detroit, Mich.
Midvale Co., Nicetown, Philadelphia, Pa.
National Carbon Co., Inc., New York
Ohio Steel Foundry Co., Springfield, Ohio
Pressed Steel Co., Wilkes-Barre, Pa.
Rolock, Inc., Fairfield, Conn.
Standard Alloy Co., Cleveland
Stanwood Corp., Chicago
Sterling Alloys Co., Woburn, Mass.
Surface Combustion, Toledo, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.
Wean Engineering Co., Inc., Warren, Ohio
Whitehead Metal Products Co., New York

ANNEALING CRATES [19]
Alloy Casting Co., Champaign, Ill.
Amer. Mang. Steel Div., American Brake Shoe Co., Chicago Hts.
Cambridge Wire Cloth Co., Cambridge, Md.
Chicago Steel Foundry Co., Chicago, Ill.
Duraloy Co., Scottdale, Pa.
Fahralloy Co., Harvey, Ill.
General Alloys Co., Boston, Mass.
Hoskins Mfg. Co., Detroit, Mich.
Rolock, Inc., Fairfield, Conn.
Standard Alloy Co., Cleveland
Stanwood Corp., Chicago
Sterling Alloys Co., Woburn, Mass.
Tate-Jones & Co., Inc., Leetsdale, Pa.
W. S. Tyler Co., Cleveland
Union Steel Products Co., Albion, Mich.
Whitehead Metal Products Co., New York

ANODES, ELECTROPLATING [20]
American Brass Co., Waterbury, Conn.
Baker & Co., Newark, N. J.
Chase Brass & Cop. Co., Waterbury, Conn.
Crown Rheostat & Supply Co., Chicago
E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.
Duriron Co., Inc., Dayton, O.
Eagle-Picher Sales Co., Cincinnati, O.
Handy & Harman, New York
Hanson-Van Winkle-Munning Co., Matawan, N. J.
Harshaw Chemical Co., Cleveland
Heil & Co., Cleveland
MacDermid, Inc., Waterbury, Conn.
Meaker Co., Chicago
Metallurgical Products Co., Philadelphia
National Carbon Co., Inc., New York
Revere Copper & Brass Co., New York
E. H. Sargent & Co., Chicago, Ill.
U. S. Stoneware Co., Akron, Ohio

ANODIZING EQUIPMENT [21]
Columbia Elec. Mfg. Co., Cleveland
Crown Rheostat & Supply Co., Chicago
Duriron Co., Inc., Dayton, O.
Enthone Co., New Haven, Conn.
Frederick Gumm Chem. Co., Kearny, N. J.
Hanson-Van Winkle-Munning, Matawan, N. J.
Heil & Co., Cleveland
Hobart Brothers Co., Troy, Ohio
Chas. F. L'Hommedieu & Sons Co., Chicago
MacDermid, Inc., Waterbury, Conn.
Frederic B. Stevens, Inc., Detroit
Udylite Corp., Detroit

ARRESTERS—Dust [22]
Aget-Detroit Mfg. Co., Detroit
American Blower Corp., Detroit
Amer. F'dry Equip. Co., Mishawaka, Ind.
Macleod Co., Cincinnati, Ohio
Newcomb-Detroit Co., Detroit
Pangborn Corp., Hagerstown, Md.
Parsons Engr. Corp., Cleveland, Ohio
W. W. Sly Mfg. Co., Cleveland, Ohio
Tabor Mfg. Co., Philadelphia
Torit Mfg. Co., St. Paul, Minn.
Westinghouse Elec. & Mfg. Co., E. Pgh.

ASBESTOS [23]
Asbestos Textile Co., Chicago
Philip Carey Mfg. Co., Cincinnati,
Foote Mineral Co., Philadelphia, Pa.
Johns-Manville, New York
Keasbey & Mattison Co., Ambler, Pa.
Manhattan Rubber Mfg. Div., Raybestos Manhattan, Inc., Passaic, N. J.
F. E. Schindler Co., Inc., Long Island

ATMOSPHERE EQUIPMENT & CONTROL [24]
Amer. Electric Furnace Co., Boston
Amer. Gas Assn., New York City
Amer. Gas Furnace Co., Elizabeth, N.
Barber-Colman Co., Rockford, Ill.
Continental Ind. Eng., Inc., Chicago,
DeBothezat Ventilating Equipment East Moline, Ill.
Drever Co., Philadelphia
Electric Furnace Co., Salem, O.
Foote Mineral Co., Philadelphia
Foxboro Co., Foxboro, Mass.
General Electric Co., Schenectady, N.
Claud S. Gordon Co., Chicago, Ill.
Hevi Duty Electric Co., Milwaukee
Holcroft & Co., Detroit, Mich.
C. M. Kemp Mfg. Co., Baltimore, Md.
Charles F. Kenworthy, Waterbury, C
James H. Knapp Co., Los Angeles
Kold-Hold Mfg. Co., Lansing, Mich.
Lindberg Engineering Co., Chicago, Ill.
Lithium Co., Newark, N. J.
MacDermid, Inc., Waterbury, Conn.
Mahr Mfg. Co., Minneapolis
Niagara Blower Co., New York
Salem Engineering Co., Salem, Ohio
Sentry Co., Foxboro, Mass.
Stewart Furnace Div., Chicago Flex. S Co., Chicago
Stow Mfg. Co., Binghamton, N. Y.
Surface Combustion, Toledo, Ohio
Sweden Freezer Mfg. Co., Seattle, Wa
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia, Pa.
Westinghouse Elec. & Mfg. Co., E. Pgh.
Lee Wilson Engrg. Co., Cleveland

BABBITT METALS [25]
Ajax Metal Co., Philadelphia
Beals-McCarthy & Rogers, Inc., Buffa
Bohn Alum. & Brass Corp., Detroit
Bunting Brass & Bronze Co., Toledo,
A. W. Cadman Mfg. Co., Pittsburgh, Pa.
Eagle-Picher Sales Co., Cincinnati, Oh
Eclipse Fuel Engr. Co., Rockford, Ill.
Federal-Mogul Corp., Detroit
McCauley Alloy Co., Chicago Hts., Ill.
Metals Refining Co., Hammond, Ind.
Metallurgical Products Co., Philadelph
National Bearing Metals Corp., St. L
Nat'l Lead Co., New York
Horace T. Potts Co., Philadelphia, Pa.
Jos. T. Ryerson & Son, Inc., Chicago
U. S. Steel Supply Co., Chicago

BALANCING MACHINES [26]
Anderson Bros. Mfg. Co., Rockford, Ill.
Bear Manufacturing Co., Rock Island,
Commerce Pattern Foundry & Mach., Detroit
Ideal Commutator Dresser, Sycamore,
Tinius Olsen Testing Machine Co., Ph
Toledo Scale Co., Toledo
Westinghouse Elec. & Mfg. Co., E. Pgh.

BAND SAWS—Metal Cutting [27]
E. C. Atkins & Co., Indianapolis, Ind.
Beals-McCarthy & Rogers, Inc., Buffalo
Brown-Wales Co., Boston, Mass.
Capewell Mfg. Co., Hartford, Conn.
Clemson Bros., Middletown, N. Y.
Continental Machines, Inc., Minneapoli
Henry Disston & Sons, Inc., Phila., Pa.
Grob Bros., Grafton, Wis.
W. J. Holliday & Co., Hammond, Ind.
Johnson Mfg. Corp., New York
Millers Falls Co., Greenfield, Mass.
Jos. T. Ryerson & Son, Inc., Chicago
Simonds Saw & Steel, Fitchburg, Mass.
L. S. Starrett Co., Athol, Mass.
Sweden Freezer Mfg. Co., Seattle, Wa
Henry G. Thompson & Son Co., Haven, Conn.
Victor Saw Wks., Middletown, N. Y.
Wells Mfg. Corp., Three Rivers, Mich.
Westinghouse Elec. & Mfg. Co., E. Pgh.,

BAR DRAWING & STRAIGHTENI MACHINES [28]
Aetna Standard Engr. Co., Youngstown,

Mfg Co., Cleveland, Ohio
press, Inc., New York City
s Engineering Corp., Cleveland
T. Ryerson & Son, Inc., Chicago

RELS—Air Blast Cleaning [29]
each Engr. Corp., Yonkers, N. Y.
born Corp., Hagerstown, Md.
s Engineering Corp., Cleveland

RELS—Plating [30]
n Rheostat & Supply Co., Chicago
ne Co., New Haven, Conn.
son-Van Winkle-Munning, Matawan, J.
F. L'Hommedieu & Sons Co., Chicago
Dermid, Inc., Waterbury, Conn.
ansohoff, Inc., Cincinnati, Ohio
Galvanizing & Plating Equipment
p., Brooklyn, N. Y.

RELS—Tumbling [31]
t Ball Co., Hartford, Conn.
Fdry Equip. Co., Mishawaka, Ind.
Machinery Co., Stratford, Conn.
Cramer Co., Inc., Centerbrook, Conn.
n Rheostat & Supply Co., Chicago
Machine & Stamping Co., Cleveland
erick Gumm Chem. Co., Kearny, N. J.
son-Van Winkle-Munning, Matawan, J.
ford Steel Ball Co., Hartford, Conn.
ard Engr. & Mfg. Co., Cincinnati
Dermid, Inc., Waterbury, Conn.
born Corp., Hagerstown, Md.
ons Engineering Corp., Cleveland
ed Steel Co., Wilkes-Barre, Pa.
ansohoff, Inc., Cincinnati, Ohio
W. Sly Mfg. Co., Cleveland, Ohio
enc B. Stevens, Inc., Detroit
gis Prod. Co., Sturgis, Mich.
on Engr. Co., Pittsburgh
r Mfg. Co., Philadelphia
ing Corp., Harvey, Ill.

S—Alloy [32]
rn Steel Co., Boston, Mass.
inum Co. of America, Pittsburgh, Pa.
erican Brass Co., Waterbury, Conn
erican Steel & Wire, Cleveland, Ohio
k-McCarthy & Rogers, Inc., Buffalo
edict Miller, Inc., Newark, N. J.
lehem Steel Co., Bethlehem, Pa.
s & Laughlin, Inc., Harvey, Ill.
wn-Wales Co., Boston, Mass.
gess-Parr Co., Freeport, Ill.
negie-Illinois Steel Corp., Pgh., Pa.
penter Steel Co., Reading, Pa.
se Brass & Cop. Co., Waterbury, Conn.
mbia Steel Co., San Francisco, Calif.
perweld Steel Co., Warren, Ohio
y Metals, Philadelphia, Pa.
y Disston & Sons, Inc., Philadelphia
ur B. Driver Co., Newark, N. J.
er-Harris Co., Harrison, N. J.
b-Sterling Steel Co., McKeesport, Pa.
mmons Co., Youngstown, Ohio
nsbee Steel Corp., Pittsburgh, Pa.
r A. Frasse & Co., Inc., New York
eral Alloys Co., Boston, Mass.
st Lakes Steel Corp., Ecorse, Detroit
nes Stellite Co., Kokomo, Ind.
penstall Co., Pittsburgh, Pa.
J. Holliday & Co., Hammond, Ind.
kins Mfg. Co., Detroit
ersoll Steel & Disc Div., Borg-Warner
orp., New Castle, Ind.
nd Steel Co., Chicago
ernational Nickel Co., New York
es & Laughlin Steel Corp., Pittsburgh
lyn Mfg. & Supply Co., Ft. Wayne, Ind.
robe Electric Steel Co., Latrobe, Pa.
ith Steel Co., New York
R. Mallory & Co., Indianapolis, Ind.
ganese Steel Forge Co., Philadelphia
dale Co., Nicetown, Philadelphia, Pa.
narch Steel Co., Indianapolis, Ind.
insular Steel Co., Cleveland
ace T. Potts Co., Philadelphia, Pa.
public Steel Corp., Cleveland, Ohio
ere Copper & Brass Co., New York
nolds Metals Co., Louisville, Ky.
ary Electric Steel Co., Detroit, Mich.
stless Iron & Steel Corp., Balt., Md.
. T. Ryerson & Son, Inc., Chicago
F Steels, Inc., New York City
n. Coal, Iron & R. R. Co., Birm., Ala.
S. Steel Supply Co., Chicago
gar T. Ward's Sons Co., Pittsburgh, Pa.
eelock, Lovejoy, Cambridge, Mass.
itehead Metal Products Co., New York
thington Pump & Machinery Corp., Harrison, N. J.

Wyckoff Drawn Steel Co., Pittsburgh
Youngstown Sheet & Tube Co., Youngstown, O.

BARS—Aluminum [33]
Ajax Metal Co., Philadelphia
Aluminum Co. of America, Pittsburgh, Pa.
Reynolds Metals Co., Louisville, Ky.
Whitehead Metal Products Co., New York

BARS—Brass, Bronze or Copper [34]
American Brass Co., Waterbury, Conn.
Ampco Metal, Inc., Milwaukee, Wis.
Atlas Brass Foundry, Los Angeles, Calif.
Beals-McCarthy & Rogers, Inc., Buffalo
Bearium Metals Corp., Rochester, N. Y.
Bound Brook Oil-Less Bearing Co., Bound Brook, N. J.
Bridgeport Brass Co., Bridgeport, Conn.
Bunting Brass & Bronze Co., Toledo, Ohio
Chase Brass & Cop. Co., Waterbury, Conn.
Chrysler Corp., Amplex Div., Detroit, Mich.
Federal-Mogul Corp., Detroit
Hammond Brass Works, Hammond, Ind.
Johnson Bronze Co., New Castle, Pa.
P. R. Mallory & Co., Inc., Indianapolis
Monarch Alloys Co., Ravenna, O.
Mueller Brass Co., Port Huron, Mich.
Horace T. Potts Co., Philadelphia, Pa.
Revere Copper & Brass Co., New York
Riverside Metal Co., Riverside, N. J.
Scomet Engr. Co., New York
Scovill Mfg. Co., Waterbury, Conn.
Titan Metal Mfg. Co., Bellefonte, Pa.
Western Cartridge Co., East Alton, Ill.
Whitehead Metal Products Co., New York

BARS—Cold Drawn [35]
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Aluminum Co. of America, Pittsburgh, Pa.
American Brass Co., Waterbury, Conn.
Amer. Steel & Wire Co., Cleveland, Ohio
Beals-McCarthy & Rogers, Inc., Buffalo
Benedict-Miller, Inc., Newark, N. J.
Bethlehem Steel Co., Bethlehem, Pa.
Bissett Steel Co., Cleveland
Bliss & Laughlin, Inc., Harvey, Ill.
Brown-Wales Co., Boston, Mass.
Carpenter Steel Co., Reading, Pa.
Chase Brass & Cop. Co., Waterbury, Conn.
Columbia Steel & Shafting Co., Pittsburgh
Copperweld Steel Co., Warren, O.
Cumberland Steel Co., Cumberland, Md.
Cuyahoga Steel & Wire Co., Cleveland, O.
Wilbur B. Driver Co., Newark, N. J.
Driver-Harris Co., Harrison, N. J.
Edgcomb Steel Corp., Hillside, N. J.
Edgcomb Steel Co., Philadelphia
Ekstrand & Tholand, Inc., New York
Firth-Sterling Steel Co., McKeesport, Pa.
Fitzsimons Co., Youngstown, Ohio
Peter A. Frasse & Co., Inc., New York
W. J. Holliday & Co., Hammond, Ind.
International Nickel Co., New York
Jones & Laughlin Steel Corp., Pittsburgh
Joslyn Mfg. & Supply Co., Ft. Wayne, Ind.
Keystone Drawn Steel Co., Spring City, Pa.
La Salle Steel Co., Hammond, Ind.
Latrobe Electric Steel Co., Latrobe, Pa.
Lehigh Steel Company, New York, N. Y.
Monarch Steel Co., Indianapolis, Ind.
Peninsular Steel Co., Cleveland
Pittsburgh Steel Co., Pittsburgh, Pa.
Pitt. Tool Steel Wire Co., Monaca, Pa.
Horace T. Potts Co., Philadelphia, Pa.
A. R. Purdy Co., New York
A. B. & J. Rathbone, Palmer, Mass.
Republic Steel Corp., Cleveland, Ohio
Reynolds Metals Co., Louisville, Ky.
Rotary Electric Steel Co., Detroit, Mich.
Jos. T. Ryerson & Son, Inc., Chicago
Timken Roller Bearing Co., Canton, O.
U. S. Steel Supply Co., Chicago
Edgar T. Ward's Sons Co., Pittsburgh, Pa.
Whitehead Metal Products Co., New York
Wyckoff Drawn Steel Co., Pittsburgh

BARS—Cold Rolled [36]
Aluminum Co. of America, Pittsburgh, Pa.
American Brass Co., Waterbury, Conn.
Beals-McCarthy & Rogers, Inc., Buffalo
Bethlehem Steel Company, Bethlehem, Pa.
Bliss & Laughlin, Inc., Harvey, Ill.
Brown-Wales Co., Boston, Mass.
Carnegie-Illinois Steel Corp., Pgh., Pa.
Carpenter Steel Co., Reading, Pa.
Cumberland Steel Co., Cumberland, Md.
Wilbur B. Driver Co., Newark, N. J.
Edgcomb Steel Corp., Hillside, N. J.
Ekstrand & Tholand, Inc., New York
Peter A. Frasse & Co., Inc., New York
Firth-Sterling Steel Co., McKeesport, Pa.
W. J. Holliday & Co., Hammond, Ind.
International Nickel Co., Inc., N. Y. City
Jones & Laughlin Steel Corp., Pittsburgh
La Salle Steel Co., Hammond, Ind.
Lehigh Steel Company, New York, N. Y.
Peninsular Steel Co., Cleveland
Horace T. Potts Co., Philadelphia, Pa.
Republic Steel Corp., Cleveland, Ohio
Reynolds Metals Co., Louisville, Ky.
Riverside Metal Co., Riverside, N. J.
Jos. T. Ryerson & Son, Inc., Chicago
Timken Roller Bearing Co., Canton, O.
Edgar T. Ward's Sons Co., Pittsburgh, Pa.
Western Cartridge Co., East Alton, Ill.

BARS—Magnesium Alloys [37]
Aluminum Co. of America, Pittsburgh, Pa.
Amer. Magnesium Corp., Pittsburgh, Pa.
Dow Chemical Co., Midland, Mich.

BARS—Rustless [38]
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
American Brass Co., Waterbury, Conn.
Amer. Steel & Wire, Cleveland, Ohio
Beals-McCarthy & Rogers, Inc., Buffalo
Brown-Wales Co., Boston, Mass.
G. O. Carlson, Inc., Thorndale, Pa.
Carnegie-Illinois Steel Corp., Pgh., Pa.
Carpenter Steel Co., Reading, Pa.
Columbia Steel Co., San Francisco, Calif.
Wilbur B. Driver Co., Newark, N. J.
Edgcomb Steel Corp., Hillside, N. J.
Firth-Sterling Steel Co., McKeesport, Pa.
Peter A. Frasse & Co., Inc., New York
General Alloys Co., Boston, Mass.
Industrial Steels, Inc., Cambridge, Mass.
International Nickel Co., New York
Joslyn Mfg. & Supply Co., Ft. Wayne, Ind.
Chas. E. Larson & Sons, Inc., Chicago
Latrobe Electric Steel Co., Latrobe, Pa.
Midvale Co., Nicetown, Philadelphia, Pa.
Horace T. Potts Co., Philadelphia, Pa.
Republic Steel Corp., Cleveland, Ohio
Rustless Iron & Steel Corp., Balt., Md.
Jos. T. Ryerson & Son, Inc., Chicago
Tenn. Coal, Iron & R. R. Co., Birm., Ala.
Timken Roller Bearing Co., Canton, O.
Univ.-Cyclops Steel Corp., Bridgeville, Pa.
Edgar T. Ward's Sons Co., Pittsburgh, Pa.
Worthington Pump & Machinery Corp., Harrison, N. J.

BARS—Steel [39]
American Steel & Wire, Cleveland, Ohio
Beals-McCarthy & Rogers, Inc., Buffalo
Benedict-Miller, Inc., Newark, N. J.
Bethlehem Steel Co., Bethlehem, Pa.
Bliss & Laughlin, Inc., Harvey, Ill.
Brown-Wales Co., Boston, Mass.
Carnegie-Illinois Steel Corp., Pgh., Pa.
Carpenter Steel Co., Reading, Pa.
Columbia Steel Co., San Francisco, Calif.
Columbia Tool Steel Co., Chicago Hts., Ill.
Copperweld Steel Co., Warren, O.
Cumberland Steel Co., Cumberland, Md.
Continental Steel Corp., Kokomo, Ind.
Cuyahoga Steel & Wire Co., Cleveland, O.
Henry Disston & Sons, Inc., Phila., Pa.
Ekstrand & Tholand, Inc., New York
Firth-Sterling Steel Co., McKeesport, Pa.
Follansbee Steel Corp., Pittsburgh, Pa.
Peter A. Frasse & Co., Inc., New York
Great Lakes Steel Corp., Ecorse, Detroit
Heppenstall Co., Pittsburgh, Pa.
W. J. Holliday & Co., Hammond, Ind.
Ingersoll Steel & Disc Div., Borg-Warner Corp., New Castle, Ind.
Inland Steel Co., Chicago
Jones & Laughlin Steel Corp., Pittsburgh
Joslyn Mfg. & Supply Co., Ft. Wayne, Ind.
Laclede Steel Co., St. Louis, Mo.
LaSalle Steel Co., Chicago
Chas. E. Larson & Sons, Inc., Chicago
Latrobe Electric Steel Co., Latrobe, Pa.
Lehigh Steel Co., New York
Monarch Steel Co., Indianapolis, Ind.
National Steel Corp., Pittsburgh, Pa.
Peninsular Steel Co., Cleveland
Horace T. Potts Co., Philadelphia, Pa.
Republic Steel Corp., Cleveland, Ohio
Jos. T. Ryerson & Son, Inc., Chicago
Sutton Engr. Co., Pittsburgh, Pa.
Tenn. Coal, Iron & R. R. Co., Birm., Ala.
U. S. Steel Supply Co., Chicago
Timken Roller Bearing Co., Canton, O.
Edgar T. Ward's Sons Co., Pittsburgh, Pa.
Weirton Steel Co., Weirton, W. Va.
Wheelock, Lovejoy, Cambridge, Mass.
Wyckoff Drawn Steel Co., Pittsburgh, Pa.
Youngstown Sheet & Tube Co., Youngstown, O.

BASKETS—Dipping [40]
Alloy Casting Co., Champaign, Ill.
American Hard Rubber Co., New York
Amer. Mang. Steel Div., American Brake Shoe Co., Chicago Hts.
Ampco Metal, Inc., Milwaukee, Wis.
Bell & Gossett Co., Chicago, Ill.
Buffalo Wire Wks. Co., Buffalo
Calorizing Co., Pittsburgh, Pa.
Cambridge Wire Cloth Co., Cambridge, Md.
Chicago Steel Foundry Co., Chicago, Ill.
Crown Rheostat & Supply Co., Chicago
Driver-Harris Co., Harrison, N. J.
Wilbur B. Driver Co., Newark, N. J.
Duriron Co., Inc., Dayton, O.
Eclipse Fuel Engr. Co., Rockford, Ill.
General Alloys Co., Boston, Mass.
Hanson-Van Winkle-Munning, Matawan, N. J.
C. O. Jelliff Mfg. Corp., Southport, Conn.
Kirk and Blum Mfg. Co., Cincinnati, Ohio
Ludlow-Saylor Wire Co., St. Louis
MacDermid, Inc., Waterbury, Conn.
Manhattan Rubber Mfg. Div., Raybestos-Manhattan, Inc., Passaic, N. J.
Michiana Prod. Corp., Michigan City, Ind.
Michigan Steel Casting Co., Detroit
Ohio Steel Foundry Co., Springfield. O.
Parsons Engr. Corp., Cleveland, Ohio
Pressed Steel Co., Wilkes-Barre, Pa.
Rolock, Inc., Fairfield, Conn.
Stanwood Corp., Chicago
Sterling Alloys Co., Woburn, Mass.
Tate-Jones & Co., Inc., Leetsdale, Pa.
W. S. Tyler Co., Cleveland
Union Steel Products Co., Albion, Mich.
Whitehead Metal Products Co., New York

BEARINGS [41]
Ampco Metal, Inc., Milwaukee, Wis.
Atlas Brass Foundry, Los Angeles, Calif.
Beals-McCarthy & Rogers, Inc., Buffalo
Bearium Metals Corp., Rochester, N. Y.
Bound Brook Oil-Less Bearing Co., Bound Brook, N. J.
Buckeye Brass & Mfg. Co., Cleveland, O.
Bunting Brass & Bronze Co., Toledo, O.
Chrysler Corp., Amplex Div., Detroit, Mich.
Federal-Mogul Corp., Detroit
Gatke Corporation, Chicago
Hammond Brass Works, Hammond, Ind.
Hartford Steel Ball Co., Hartford, Conn.
Jeffrey Mfg. Co., Columbus, Ohio
Johnson Bronze Co., New Castle, Pa.
Keystone Carbon Co., St. Marys, Pa.
P. R. Mallory & Co., Inc., Indianapolis
Manhattan Rubber Mfg. Div., Raybestos-Manhattan, Inc., Passaic, N. J.
McCauley Alloy Co., Chicago Hts., Ill.
Monarch Alloys Co., Ravenna, O.
Moraine Products Div., Dayton, O.
National Bearing Metals Corp., St. Louis
Neveroil Bearing Co., Wakefield, Mass.
Palmer-Bee Co., Detroit
Horace T. Potts Co., Philadelphia, Pa.
Revere Copper & Brass, Inc., New York
R. W. Rhoades Metaline Co., Inc., Long Island City, N. Y.
Roller Bearing Co. of Amer., Trenton, N. J.
Shenango-Penn Mold Co., Dover, Ohio
SKF Steels, Inc., New York
Standard Mach. Co., Providence, R. I.
Stephens-Adamson Mfg. Co., Aurora, Ill.
Timken Roller Bearing Co., Canton, O.
U. S. Graphite Co., Saginaw, Mich.

BEARINGS—Anti-friction [42]
Bohn Alum. & Brass Corp., Detroit
Johns-Manville Co., New York
Link-Belt Co., Indianapolis
P. R. Mallory & Co., Inc., Indianapolis
National Carbon Co., Inc., Cleveland
Roller Bearing Co. of Amer., Trenton, N. J.
SKF Steels, Inc., New York
Standard Machinery Co., Providence, R. I.
Stephens-Adamson Mfg. Co., Aurora, Ill.
Timken Roller Bearing Co., Canton, O.

BELTING—Conveyor Metal [43]
Audubon Wire Cloth Corp., Philadelphia
Beals-McCarthy & Rogers, Inc., Buffalo
Cambridge Wire Cloth Co., Cambridge, Md.
Chicago Steel Foundry Co., Chicago
Cyclone Fence Div., Amer. Steel & Wire Co., Waukegan, Ill.
Wilbur B. Driver Co., Newark, N. J.
Sandvik Steel, Inc., New York City
Wickwire Spencer Steel Co., New York

BENDING MACHINES [44]
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia, Pa.
Buffalo Forge Co., Buffalo, N. Y.
Chambersburg Eng. Co., Chambersb'g, Pa.
Hydropress, Inc., New York City
Lake Erie Engr. Corp., Buffalo, N. Y.
Parker Appliance Co., Cleveland
Parsons Engineering Corp., Cleveland
Pines Engineering Co., Aurora, Ill.
J. A. Richards Co., Kalamazoo, Mich.
Riehle Testing Machine Div.: American Machine & Metals, Inc., East Moline, Ill.
U. S. Steel Supply Co., Chicago
Universal Power Corp., Cleveland
Yoder Co., Cleveland

BERYLLIUM COPPER [45]
American Brass Co., Waterbury, Conn.
Ampco Metal, Inc., Milwaukee, Wis.
Beryllium Corp. of Pa., Reading, Pa.
Brush Beryllium Co., Cleveland, Ohio
Callite Tungsten Corp., Union City, N. J.
Wilbur B. Driver Co., Newark, N. J.
Foote Mineral Co., Philadelphia, Pa.
P. R. Mallory & Co., Indianapolis, Ind.
Riverside Metal Co., Riverside, N. J.
Summerill Tubing Co., Bridgeport, Pa.
Whitehead Metal Products Co., New York

BILLETS [46]
Aluminum Co. of America, Pittsburgh, Pa.
American Steel & Wire, Cleveland, Ohio
Andrews Steel Co., Newport, Ky.
Atlantic Steel Co., New York
Bethlehem Steel Co., Bethlehem, Pa.
Carnegie-Illinois Steel Corp., Pgh., Pa.
Columbia Steel Co., San Francisco, Calif
Continental Steel Corp., Kokomo, Ind.
Copperweld Steel Co., Warren, O.
Wilbur B. Driver Co., Newark, N. J.
Firth-Sterling Steel Co., McKeesport, Pa.
Follansbee Steel Corp., Pittsburgh, Pa.
Great Lakes Steel Corp., Ecorse, Detroit
Heppenstall Co., Pittsburgh, Pa.
W. J. Holliday & Co., Hammond, Ind.
Inland Steel Co., Chicago
Wm. Jessop & Sons, New York
Jones & Laughlin Steel Corp., Pittsburgh
Joslyn Mfg. & Supply Co., Ft. Wayne, Ind.
Lehigh Steel Co., New York
Lukens Steel Co., Coatesville, Pa.
Midvale Co., Nicetown, Philadelphia, Pa.
National Forge & Ordnance Co., Irvine, Warren County, Pa.
Republic Steel Corp., Cleveland, Ohio
Rotary Electric Steel Co., Detroit
Jos. T. Ryerson & Son, Inc., Chicago
Swedish-American Steel Corp., Brooklyn
Tenn. Coal, Iron & R. R. Co., Birm., Ala.
U. S. Steel Supply Co., Chicago
Univ.-Cyclops Steel Corp., Bridgeville, Pa.
Wheelock, Lovejoy, Cambridge, Mass.

BILLETS—Rustless [47]
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
G. O. Carlson, Inc., Thorndale, Pa.
Carnegie-Illinois Steel Corp., Pgh., Pa.
Carpenter Steel Co., Reading, Pa.
Wilbur B. Driver Co., Newark, N. J.
Firth-Sterling Steel Co., McKeesport, Pa.
Joslyn Mfg. & Supply Co., Ft. Wayne, Ind.
Latrobe Electric Steel Co., Latrobe, Pa.
Midvale Co., Nicetown, Philadelphia, Pa.
Republic Steel Corp., Cleveland, Ohio
Rustless Iron & Steel Corp., Balt., Md.
Jos. T. Ryerson & Son, Inc., Chicago

BIMETALS—Thermostatic [48]
Baker & Co., Inc., Newark, N. J.
Callite Tungsten Corp., Union City, N. J.
W. M. Chace Co., Detroit
Dole Valve Co., Chicago, Ill.
Driver-Harris Co., Harrison, N. J.
Westinghouse Elec. & Mfg. Co., E. Pgh., Pa.
H. A. Wilson Co., Newark, N. J.

BLAST CLEANING EQUIPMENT [49]
Amer. F'dry Equip. Co., Mishawaka, Ind.
Callite Tungsten Corp., Union City, N. J.
Dreisbach Engr. Corp., Yonkers, N. Y.
Leiman Bros., Newark, N. J.
Macleod Co., Cincinnati, Ohio
National Metal Abrasive Co., Cleveland
Pangborn Corp., Hagerstown, Md.
Parsons Engr. Corp., Cleveland, Ohio
Quincy Compressor Co., Quincy, Ill.
Ruemelin Mfg. Co., Milwaukee, Wis.
W. W. Sly Mfg. Co., Cleveland, Ohio
Whiting Corp., Harvey, Ill.

BLASTING GRAIN—Pressure [50]
Abrasive Co., Philadelphia
Carborundum Co., Niagara Falls, N. Y.
Harrison Abrasive Corp., Manchester, N. H.
National Metal Abrasive Co., Cleveland

BLOWERS [51]
American Blower Corp., Detroit
Amer. Gas Furnace Co., Elizabeth, N
Beach Russ Co., New York
Buffalo Forge Co., Buffalo, N. Y.
Campbell-Hausfeld Co., Harrison, O.
Chicago Flexible Shaft Co., Chicag
Chicago Steel Foundry Co., Chicago
Cuno Engineering Co., Meriden, Con
Davis Emergency Equip. Co., Newark
DeLaval Steam Turbine Co., Trento
Eclipse Fuel Eng'ring Co., Rockford
M. K. Epstein Co., Springfield, Mas
Fisher Furnace Co., Chicago, Ill.
Claud S. Gordon Co., Chicago, Ill.
Heilman Boiler Works, Allentown, P
Ideal Commutator Dress. Co., Sycamo
Ingersoll-Rand Co., New York
Jeffrey Mfg. Co., Columbus, Ohio
Leiman Bros., Newark, N. J.
Mahr Mfg. Co., Minneapolis, Minn.
Maxon Premix Burner Co., Muncie,
Nat'l Machine Wks., Chicago
Niagara Blower Co., New York
North American Mfg. Co., Clevela
Parsons Engr. Corp., Cleveland, Oh
Petersen Oven Co., Chicago
Roots-Connersville Blower Corp., Con ville, Ind.
W. S. Rockwell Co., New York
Skilsaw, Inc., Chicago
Spencer Turbine Co., Hartford, Conn
B. F. Sturtevant Co., Boston, Mass.
Tate-Jones & Co., Inc., Leetsdale, P
Vulcan Corp., Philadelphia, Pa.

BLOWERS—Turbo [52]
Allis-Chalmers Mfg. Co., Milwauke
Amer. Gas Furnace Co., Elizabeth, N
Chicago Steel Foundry Co., Chicago
Cuno Engineering Co., Meriden, Con
DeBothezat Vent. Equip. Div., Amer. & Metals, Inc., E. Moline, Ill.
M. K. Epstein Co., Springfield, Mas
Fisher Furnace Co., Chicago, Ill.
Claud S. Gordon Co., Chicago, Ill.
Ingersoll-Rand Co., Phillipsburg, N.
Mahr Manufacturing Co., Minneapo
North American Mfg. Co., Cleve.a
Sellers Engrg. Co., Chicago
Spencer Turbine Co., Hartford, Minn
Tate-Jones & Co., Inc., Leetsdale, P
U. S. Hoffman Mach. Corp., New Y
Vulcan Corp., Philadelphia, Pa.
Whiting Corp., Harvey, Ill.

BLOWPIPES [53]
Air Reduction, New York
Amer. Gas Furnace Co., Elizabeth, N
Johnson Gas Appl. Co., Cedar Rapid
Newcomb-Detroit Co., Detroit
Ohio Steel Foundry Co., Springfield,
Parsons Engr. Corp., Cleveland, Ohi
Torit Mfg. Co., St. Paul, Minn.
Universal Power Corp., Cleveland

BLOWPIPES—Oxy-Acetylene, Weldi Cutting [54]
Air Reduction, New York
General Welding & Equip. Co., Bosto
Harris Calorific Co., Cleveland, Ohio
Linde Air Products Co., New York
National Cylinder Gas Co., Chicago,
Smith Welding Equip. Co., Minneapo
Universal Power Corp., Cleveland
Victor Equipment Co., San Francisco

BOLT, NUT, RIVET MACHINERY
Acme Machinery Div., Hill Acme Cleveland, Ohio
Ajax Mfg. Co., Cleveland, Ohio
Milford Rivet & Mach. Co., Milford,
National Machinery Co., Tiffin, Ohio
Sweden Freezer Mfg. Co., Seattle, W

BOXES—Carburizing—See Carburi Boxes

BRASS AND BRONZE [56]
Ajax Metal Co., Philadelphia
American Brass Co., Waterbury, Con
Ampco Metal, Inc., Milwaukee, Wis.
Beals-McCarthy & Rogers, Inc., Buffa
Bearium Metals Corp., Rochester, N.
Bohn Alum. & Brass Corp., Detroit
Bound Brook Oil-Less Bearing Co., B Brook, N. J.
Bridgeport Brass Co., Bridgeport, Co
Buckeye Brass & Mfg. Co., Cleveland,
Bunting Brass & Bronze Co., Toledo,
Callite Tungsten Corp., Union City,
Chase Brass & Cop. Co., Waterbury,
Federal-Mogul Corp., Detroit
Frontier Bronze Corp., Niag. Falls, N

mmond Brass Works, Hammond, Ind.
nson Bronze Co., New Castle, Pa.
ppers Co., Pittsburgh
men Bearing Co., Buffalo
er Co., Meriden, Conn.
earch Alloys Co., Ravenna, O.
eller Brass Co., Port Huron, Mich.
ara Falls Smelting & Refining Corp., Buffalo, N. Y.
race T. Potts Co., Philadelphia, Pa.
vere Copper & Brass Co., New York
erside Metal Co., Riverside, N. J.
rill Mfg. Co., Waterbury, Conn.
an Metal Mfg. Co., Bellefonte, Pa.
-Clover Machine Co., Kenosha, Wis.
S. Reduction Co., E. Chicago, Ind.
stern Cartridge Co., East Alton, Ill.
itehead Metal Products Co., New York
illiams & Co., Pittsburgh

RAZING—Belts & Trays [57]
dubon Wire Cloth Corp., Philadelphia
mbridge Wire Cloth Co., Cambridge, Md.
neral Alloys Co., Boston, Mass.
chigan Steel Casting Co., Detroit
lock, Inc., Fairfield, Conn.
andard Alloy Co., Cleveland
erling-Alloys, Inc., Woburn, Mass.

RAZING—Electric [58]
ax Electrothermic Corp., Trenton, N. J.
erican Car & Foundry Co., New York
ner. Elec. Furnace Co., Boston
ntinental Industrial Engineers, Chicago
bert Cummins & Co., Baltimore, Md.
to High Frequency Elec. Corp., No. Bergen, N. J.
deral Tel. & Radio Corp., Newark, N. J.
neral Electric Co., Schenectady, N. Y.
aud S. Gordon Co., Chicago, Ill.
ri Duty Electric Co., Milwaukee, Wis.
. F. Holden Co., New Haven, Conn.
skins Mfg. Co., Detroit, Mich.
el Commutator Dresser Co., Sycamore, Ill.
duction Heating Corp., New York
pel High Freq. Labs., Inc., New York
to Crankshaft Co., Cleveland, Ohio
een City Steel Treating Co., Cincinnati
kover Metal Processing Co., Chicago
rold E. Trent Co., Philadelphia, Pa.
niversal Power Corp., Cleveland
Norman Mach. Tool Co., Springfield, Mass.
ican Corp., Philadelphia, Pa.
ll-Colmonoy Corp., Detroit
estinghouse Electric & Mfg. Co., E. Pgh.

RAZING—Furnaces [59]
ax Electric Co., Inc., Philadelphia
ax Electrothermic Corp., Trenton, N. J.
erican Electric Furnace Co., Boston
ner. Gas Furnace Co., Elizabeth, N. J.
ker & Co., Newark, N. J.
lis Heat Treating Co., Branford, Conn.
icago Flexible Shaft Co., Chicago
ntinental Industrial Engineers, Chicago
laware Tool Steel Co., Wilmington, Del.
otch Oven Co., Minneapolis, Minn.
lipse Fuel Eng'ring Co., Rockford, Ill.
ctric Furnace Co., Salem, O.
ctro Ref. & Alloys Corp., Buffalo
deral Tel. & Radio Corp., Newark, N. J.
rth-Sterling Steel Co., McKeesport, Pa.
neral Electric Co., Schenectady, N. Y.
aud S. Gordon Co., Chicago, Ill.
arper Elec. Fur. Corp., Niagara Falls, N. Y.
ri Duty Electric Co., Milwaukee, Wis.
oleroft & Co., Detroit, Mich.
. F. Holden Co., New Haven, Conn.
skins Mfg. Co., Detroit, Mich.
duction Heating Corp., New York
hnson Gas Appl. Co., Cedar Rapids, Ia.
pel High Freq. Labs., Inc., New York
ndberg Engineering Co., Chicago, Ill.
rrison Engineering Co., Cleveland
to Crankshaft Co., Cleveland
. S. Rockwell Co., New York
lem Engineering Co., Salem, Ohio
ntry Co., Foxboro, Mass.
rface Combustion, Toledo, Ohio
te-Jones & Co., Inc., Leetsdale, Pa.
pton Electric Furnace Div., Commerce Pattern Foundry & Mach. Co., Detroit
lcan Corp., Philadelphia, Pa.
estinghouse Electric & Mfg. Co., E. Pgh.

RAZING—Rods and Alloys [60]
r Reduction, New York
ddin Rod & Flux Mfg. Co., Grand Rapids, Mich.
uminum Co. of America,, Pittsburgh, Pa.
ner. Brass Co., Waterbury, Conn.
Beals-McCarthy & Rogers, Inc., Buffalo
Chase Brass & Cop. Co., Waterbury, Conn.
Eutectic Welding Alloys, Inc., New York
General Alloys Co., Boston, Mass.
Handy & Harman, New York
Krembs & Co., Chicago
Linde Air Products Co., New York
McCauley Alloy Co., Chicago Hts., Ill.
National Cylinder Gas Co., Chicago, Ill.
Horace T. Potts Co., Philadelphia, Pa.
Revere Copper & Brass, Inc., New York
U. S. Steel Supply Co., Chicago
Universal Power Corp., Cleveland
Vascoloy-Ramet Corp., North Chicago
Wall-Colmonoy Corp., Detroit
Westinghouse Elec. & Mfg. Co., E. Pgh., Pa.
Whitehead Metal Products Co., New York

BRICK—Fire Clay [61]
Acme Brick Co., Ft. Worth, Texas
Armstrong Cork Co., Lancaster, Pa.
Botfield Refractories Co., Philadelphia
Brickseal Ref. Co., Hoboken, N. J.
Carborundum Co., Perth Amboy, N. J.
Federal Refractories Corp., Akron, O.
Gen. Refractories Co., Philadelphia, Pa.
A. P. Green Fire Brick Co., Mexico, Mo.
Harbison-Walker Refrac. Co., Pgh., Pa.
Illinois Clay Products Co., Joliet, Ill.
Ironton Fire Brick Co., Ironton, O.
Laclede-Christy Clay Prod. Co., St. Louis
McLeod & Henry Co., Troy, N. Y.
North Amer. Refractories Co., Cleveland
Quigley Co., Inc., New York
Frederic B. Stevens, Inc., Detroit
Chas. Taylor Sons Co., Cincinnati, O.

BRICK—Insulating—See Fire Brick—Insulating

BRICK—Refractory [62]
Acme Brick Co., Ft. Worth, Texas
Armstrong Cork Co., Lancaster, Pa.
Babcock & Wilcox Co., New York
Botfield Refractories Co., Philadelphia
Carborundum Co., Perth Amboy, N. J.
Electro Refract. & Alloys Corp., Buffalo
Federal Refractories Corp., Akron, O.
Gen. Refractories Co., Philadelphia, Pa.
A. P. Green Fire Brick Co., Mexico, Mo.
Harbison-Walker Refrac. Co., Pgh., Pa.
Illinois Clay Products Co., Joliet, Ill.
Ironton Fire Brick Co., Ironton, O.
Johns-Manville, New York
Laclede-Christy Clay Prod. Co., St. Louis
Lava Crucible Co. of Pittsburgh, Pa.
McLeod & Henry Co., Troy, N. Y.
National Carbon Co., Inc., New York
North Amer. Refractories Co., Cleveland
Norton Co., Worcester, Mass.
Plibrico Jointless Firebrick Co., Chicago
Quigley Co., Inc., New York
Ramtite Co., Chicago
Chas. Taylor Sons Co., Cincinnati, O.
Titanium Alloy Mfg. Co., Niag. Falls, N. Y.

BRINELL—See Hardness Testers

BRIQUETTES—Molybdic Oxide [63]
Climax Molybdenum Co., New York

BRONZE—See Brass and Bronze

BRONZE WELDING RODS [64]
Air Reduction, New York
American Brass Co., Waterbury, Conn.
Ampco Metal, Inc., Milwaukee, Wis.
Arcos Corp., Philadelphia, Pa.
Beals-McCarthy & Rogers, Inc., Buffalo
Bridgeport Brass Co., Bridgeport, Conn.
Eutectic Welding Alloys, Inc., New York
Krembs & Co., Chicago
Lincoln Electric Co., Cleveland
Linde Air Products Co., New York
Mueller Brass Co., Port Huron, Mich.
National Cylinder Gas Co., Chicago
Horace T. Potts Co., Philadelphia, Pa.
Revere Copper & Brass, Inc., New York
Riverside Metal Co., Riverside, N. J.
Titan Metal Mfg. Co., Bellefonte, Pa.
Universal Power Corp., Cleveland
U. S. Steel Supply Co., Chicago
Whitehead Metal Products Co., New York

BRUSHES—Cleaning [65]
American Brass Co., Waterbury, Conn.
MacDermid, Inc., Waterbury, Conn.
Manderscheid Co., Chicago
Osborn Mfg. Co., Cleveland, Ohio
Tolman Mfg. Co., Boston, Mass.

BUFFING AND POLISHING COMPOSITIONS [66]
American Buff Co., Chicago
Bacon Felt Co., Winchester, Mass.
Bias Buff & Wheel Co., Jersey City, N. J.
Crown Rheostat & Supply Co., Chicago
Divine Brothers Co., Utica, N. Y.
Eimer & Amend, New York
Fisher Scientific Co., Pittsburgh
Foote Mineral Co., Philadelphia, Pa.
Hanson-Van Winkle-Munning, Matawan, N. J.
Harrison & Co., Haverhill, Mass.
Johns-Manville, New York
Lea Mfg. Co., Waterbury, Conn.
MacDermid, Inc., Waterbury, Conn.
Manderscheid Co., Chicago
Matchless Metal Polish Co., Chicago
Minn. Mining & Mfg. Co., St. Paul
Park Chemical Co., Detroit, Mich.
Puritan Mfg. Co., Waterbury, Conn.
Rex Oil & Chemical Co., Cleveland
Frederic B. Stevens, Inc., Detroit
Sturgis Products Company, Sturgis, Mich.

BUFFING MACHINES [67]
Crown Rheostat & Supply Co., Chicago
Divine Brothers Co., Utica, N. Y.
Hammond Machy. Bldrs., Kalamazoo, Mich.
Chas. F. L'Hommedieu & Sons Co., Chicago
Independent Pneumatic Tool Co., Chicago
Mall Tool Co., Chicago
MacDermid, Inc., Waterbury, Conn.
Manderscheid Co., Chicago
Paasche Airbrush Co., Chicago, Ill.
Production Machine Co., Greenfield, Mass.
Skilsaw, Inc., Chicago
Sturgis Prod. Co., Sturgis, Mich.
Vonnegut Moulder Corp., Indianapolis

BUFFING, POLISHING WHEELS [68]
Advance Polishing Wheels, Inc., Chicago
American Buff Co., Chicago
Bacon Felt Co., Winchester, Mass.
Bias Buff & Wheel Co., Jersey City, N. J.
Burrell Technical Supply Co., Pittsburgh
A. P. de Sanno & Son, Phoenixville, Pa.
Divine Brothers Co., Utica, N. Y.
Eimer & Amend, New York
Fisher Scientific Co., Pittsburgh
Hanson-Van Winkle-Munning Co., Matawan, N. J.
Jackson Buff Corp., Long Island City, N. Y.
MacDermid, Inc., Waterbury, Conn.
Manderscheid Co., Chicago
Matchless Metal Polish Co., Chicago
Osborn Mfg. Co., Cleveland, Ohio
Production Machine Co., Greenfield, Mass.
Williamsville Buff Mfg., Danielson, Conn.

BULLDOZERS [69]
Ajax Mfg. Co., Cleveland, Ohio
Baldwin Southwark Div., Baldwin Locomotive Wks., Philadelphia
Chambersburg Eng. Co., Chambersb'g, Pa.
Lake Erie Engr. Corp., Buffalo, N. Y.
Jos. T. Ryerson & Son, Inc., Chicago

BURNERS—Gas [70]
Aeroil Burner Co., Inc., W. New York, N. J.
Amer. Gas Assn., New York
Amer. Gas Furnace Co., Elizabeth, N. J.
Amsler-Morton Co., Pittsburgh, Pa.
Callite Tungsten Corp., Union City, N. J.
Chicago Steel Foundry Co., Chicago
Continental Industrial Engineers, Chicago
Cuno Engineering Co., Meriden, Conn.
Driver-Harris Co., Harrison, N. J.
Eclipse Fuel Eng'ring Co., Rockford, Ill.
Eimer & Amend, New York
R. A. Ekstrom, Jr. Co., Harvey, Ill.
M. K. Epstein Co., Springfield, Mass.
F. J. Fieser Co., New York
Fisher Scientific Co., Pittsburgh
E. A. Furkert Co., Chicago, Ill.
Gas Machinery Co., Cleveland
Hauck Manufacturing Co., Brooklyn, N. Y.
A. P. Holden Co., New Haven, Conn.
Charles A. Hones, Inc., Baldwin, N. Y.
Johnson Gas Appl. Co., Cedar Rapids, Ia.
C. M. Kemp Mfg. Co., Baltimore, Md.
James H. Knapp Co., Los Angeles
MacDermid, Inc., Waterbury, Conn.
Mahr Manufacturing Co., Minneapolis
Maxon Premix Burner Co., Muncie, Ind.
Morrison Engineering Co., Inc., Cleveland
Nat'l Machine Wks., Chicago
North American Mfg. Co., Cleveland
Partlow Corp., New Hartford, N. Y.
W. S. Rockwell Co., New York
Selas Co., Philadelphia
Sellers Engrg. Co., Chicago
Surface Combustion, Toledo, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia, Pa.
Lee Wilson Engrg. Co., Cleveland

BURNERS—Oil or Gas [71]
Amsler-Morton Co., Pittsburgh, Pa.
Babcock & Wilcox Co., New York

Chicago Steel Foundry Co., Chicago, Ill.
Continental Industrial Engineers, Chicago
Dempsey Ind. Fur. Corp., Springfield, Mass.
Driver-Harris Co., Harrison, N. J.
Eclipse Fuel Engr. Co., Rockford, Ill.
M. K. Epstein Co., Springfield, Mass.
Fisher Furnace Co., Chicago, Ill.
Hauck Manufacturing Co., Brooklyn
A. F. Holden Co., New Haven, Conn.
Industrial Heating Equip. Co., Detroit
Johnson Gas Appl. Co., Cedar Rapids, Ia.
Johnston Mfg. Co., Minneapolis
C. M. Kemp Mfg. Co., Baltimore, Md.
Mahr Manufacturing Co., Minneapolis
Maxon Premix Burner Co., Muncie, Ind.
Miller Co., Meriden, Conn.
Morrison Engineering Co., Inc., Cleveland
Nat'l Machine Wks., Chicago
National Radiator Co., Johnstown, Pa.
North American Mfg. Co., Cleveland
Ohio Steel Foundry Co., Springfield, Ohio
Preferred Utilities Co., New York
W. S. Rockwell Co., New York
Surface Combustion, Toledo
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia, Pa.
Wean Engineering Co., Inc., Warren, Ohio

BURNERS—Pulverized Coal [72]
Amsler-Morton Co., Pittsburgh, Pa.
Babcock & Wilcox Co., New York
Tate-Jones & Co., Inc., Leetsdale, Pa.
Whiting Corp., Harvey, Ill.

BURNISHING BARRELS & TOOLS [73]
Baird Machine Co., Stratford, Conn.
Globe Machine & Stamping Co., Cleveland
Hartford Steel Ball Co., Hartford, Conn.
MacDermid, Inc., Waterbury, Conn.
Ohio Carbon Co., Cleveland, Ohio
N. Ransohoff, Inc., Cincinnati, Ohio
Whiting Corp., Harvey, Ill.

CABINETS—Refrigeration [74]
American Coils Co., Newark, N. J.
Amer. Instrument Co., Silver Spring, Md.
Bowser, Inc., Ft. Wayne, Ind.
Kold-Hold Mfg. Co., Lansing, Mich.
Revco, Inc., Deerfield, Mich.
Sweden Freezer Mfg. Co., Seattle, Wash.

CALCIUM METAL & ALLOYS [75]
Climax Molybdenum Co., New York
E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.
Electro Metallurgical Co., New York
Electro Ref. & Alloys Corp., Buffalo
Charles Hardy, Inc., New York
Niagara Falls Smelting & Ref. Co., Buffalo
Powder Metals & Alloys, Inc., New York

CALCIUM MOLYBDATE [76]
Climax Molybdenum Co., New York
Molybdenum Corp. of America, Pittsburgh

CARBIDE—Calcium [77]
Acetylene Gas Co., St. Louis, Mo.
Linde Air Products Co., New York
National Cylinder Gas Co., Chicago
Shawinigan Prod. Corp., Brooklyn, N. Y.
Universal Power Corp., Cleveland

CARBIDE TOOL GRINDERS [78]
Carboloy Co., Detroit, Mich.
Hammond Machy. Bldrs., Kalamazoo, Mich.
K. O. Lee & Son Co., Aberdeen, S. D.
Thomas Prosser & Son, New York

CARBIDES—Cemented—See Tools—Cemented Carbide

CARBON ELECTRODES—See Electrodes

CARBON PRODUCTS [79]
Char Prod. Co., Indianapolis, Ind.
Ecco Chemical Corp., Union City, N. J.
Electro Ref. & Alloys Corp., Buffalo
Follansbee Steel Corp., Pittsburgh, Pa.
A. F. Holden Co., New Haven, Conn.
Keystone Carbon Co., St. Marys, Pa.
Internat'l Graphite & Electrode Corp., St. Marys, Pa.
National Carbon Co., Inc., New York
National Cylinder Gas Co., Chicago
Ohio Carbon Co., Cleveland, Ohio
Park Chemical Co., Detroit, Mich.
Speer Carbon Co., St. Marys, Pa.
U. S. Graphite Co., Saginaw, Mich.

CARBURIZER SCREEN. MACH. [80]
Newcomb-Detroit Co., Detroit
Park Chemical Co., Detroit, Mich.
Thurner Engineering Co., Milwaukee

CARBURIZING—See Heat Treating

CARBURIZING BOXES [81]
Alloy Casting Co., Champaign, Ill.
Amer. Mang. Steel Div., American Brake Shoe Co., Chicago Hts.
Bell & Gossett Co., Chicago, Ill.
Case Hardening Service Co., Cleveland
Chicago Steel Foundry Co., Chicago, Ill.
Driver-Harris Co., Harrison, N. J.
Duraloy Co., Scottdale, Pa.
Eclipse Fuel Eng'ring Co., Rockford, Ill.
Electro Alloys Co., Elyria, Ohio
Fahralloy Co., Harvey, Ill.
General Alloys Co., Boston, Mass.
Claud S. Gordon Co., Chicago, Ill.
A. F. Holden Co., New Haven, Conn.
Hoskins Mfg. Co., Detroit, Mich.
Michiana Prod. Corp., Michigan City, Ind.
Michigan Steel Casting Co., Detroit
Midvale Co., Nicetown, Philadelphia, Pa.
National Carbon Co., Inc., New York
Ohio Steel Foundry Co., Springfield, O.
Pressed Steel Co., Wilkes-Barre, Pa.
Rolock, Inc., Fairfield, Conn.
Standard Alloy Co., Cleveland
Stanwood Corp., Chicago
Sterling Alloys Co., Woburn, Mass.
Tate-Jones & Co., Inc., Leetsdale, Pa.

CARBURIZING COMPOUNDS [82]
American Cyan. & Chem. Corp., New York
Bell & Gossett Co., Morton Grove, Ill.
Bellis Heat Treating Co., Branford, Conn.
Carbide & Carbon Chemicals Corp., N. Y.
Case Hardening Service Co., Cleveland
Char Products Co., Indianapolis, Ind.
E. I. du Pont de Nemours & Co., Wilmington, Del.
Ecco Chemical Corp., Weehawken, N. J.
Farrar Ind. Prod. Co., Los Angeles, Calif.
Claud S. Gordon Co., Chicago
Heatbath Corp., Springfield, Mass.
A. F. Holden Co., New Haven, Conn.
E. F. Houghton & Co., Philadelphia, Pa.
J. W. Kelley Co., Cleveland, Ohio
Mitchell-Bradford Chemical Co., Bridgeport, Conn.
Park Chemical Co., Detroit, Mich.
Rodman Chemical Co., Verona, Pa.
G. S. Rogers & Co., Chicago, Ill.
Steel Treating Equipment Co., Detroit
Wheelock, Lovejoy, Cambridge, Mass.

CARBURIZING FURNACES [83]
American Electric Furnace Co., Boston
Amer. Gas Furnace Co., Elizabeth, N. J.
Bell & Gossett Co., Chicago, Ill.
Bellis Heat Treating Co., Branford, Conn.
Case Hardening Service Co., Cleveland
Chicago Flexible Shaft Co., Chicago
Continental Industrial Engineers, Chicago
Dempsey Ind. Fur. Corp., Springfield, Mass.
Despatch Oven Co., Minneapolis, Minn.
Drever Co., Philadelphia
Eclipse Fuel Eng'ring Co., Rockford, Ill.
Electric Furnace Co., Salem, O.
M. K. Epstein Co., Springfield, Mass.
Flinn & Dreffein Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago, Ill.
Hevi Duty Electric Co., Milwaukee, Wis.
Holcroft & Co. Detroit, Mich.
A. F. Holden Co., New Haven, Conn.
Hoskins Mfg. Co., Detroit
Johnson Gas Appl. Co., Cedar Rapids, Ia.
James H. Knapp Co., Los Angeles
Leeds & Northrup Co., Philadelphia, Pa.
Lindberg Engineering Co., Chicago, Ill.
Lithium Co., Newark, N. J.
Mahr Manufacturing Co., Minneapolis
Morrison Engineering Co., Cleveland
Radiant Combustion, Inc., Warren, O.
W. S. Rockwell Co., New York
Salem Engineering Co., Salem, Ohio
Sentry Co., Foxboro, Mass.
Standard Fuel Engineering Co., Detroit
Surface Combustion, Toledo, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.
Upton Electric Salt Bath Fur. Co., Detroit
Vulcan Corp., Philadelphia, Pa.
Westinghouse Electric & Mfg. Co., E. Pgh.
Lee Wilson Engineering Co., Cleveland

CASE HARDENING—See Heat Treating

CASE HARDENING COMPOUNDS [84]
American Cyan. & Chem. Corp., New York
Bell & Gossett Co., Morton Grove, Ill.
Bellis Heat Treating Co., Branford, Conn.
Case Hardening Service Co., Cleveland
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Char Products Co., Indianapolis, Ind.
E. I. du Pont de Nemours, Wilmington
Ecco Chemical Corp., Weehawken, N. J.
M. K. Epstein Co., Springfield, Mass.
Farrar Ind. Prod. Co., Los Angeles, Calif.
Heatbath Corp., Springfield, Mass.
A. F. Holden Co., New Haven, Conn.
E. F. Houghton & Co., Philadelphia, Pa.
Kasenit Co., New York
MacDermid, Inc., Waterbury, Conn.
Mathieson Alkali Works, Inc., New York
Mitchell Bradford Chemical Co., Bridgeport, Conn.
Park Chemical Co., Detroit
Philadelphia Quartz Co., Philadelphia
Rodman Chemical Co., Verona, Pa.
G. S. Rogers & Co., Chicago, Ill.
Steel Treating Equipment Co., Detroit

CASE HARDENING FURNACES [85]
American Electric Furnace Co., Boston
Amer. Gas Furnace Co., Elizabeth, N. J.
Bell & Gossett Co., Chicago, Ill.
Bellis Heat Treating Co., Branford, Conn.
Case Hardening Service Co., Cleveland
Chicago Flexible Shaft Co., Chicago
Chicago Steel Foundry Co., Chicago, Ill.
Continental Industrial Engineers, Chicago
Dempsey Ind. Fur. Corp., Springfield, Mass.
Despatch Oven Co., Minneapolis, Minn.
Drever Co., Philadelphia, Pa.
Eclipse Fuel Eng'ring Co., Rockford, Ill.
Electric Furnace Co., Salem, O.
Flinn & Dreffein Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago
Hevi Duty Electric Co., Milwaukee, Wis.
Holcroft & Co., Detroit, Mich.
A. F. Holden Co., New Haven, Conn.
Chas. A. Hones, Inc., Baldwin, N. Y.
Kali Mfg. Co., Philadelphia, Pa.
James H. Knapp Co., Los Angeles
Leeds & Northrup Co., Philadelphia, Pa.
Lindberg Engineering Co., Chicago
Mahr Manufacturing Co., Minneapolis
Nitralloy Corp., New York
Radio Corp. of America—RCA Victor Div., Camden, N. J.
W. S. Rockwell Co., New York
Salem Engineering Co., Salem, Ohio
C. U. Scott & Son, Rock Island, Ill.
Sellers Engineering Co., Chicago
Sentry Co., Foxboro, Mass.
Standard Fuel Engineering Co., Detroit
Surface Combustion, Toledo, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.
Upton Electric Furnace Co., Detroit
Vulcan Corp., Philadelphia, Pa.
Westinghouse Electric & Mfg. Co., E. Pgh.
Lee Wilson Engineering Co., Cleveland

CASTING WASHER [86]
Amer. Fdry. Equip. Co., Mishawaka, Ind.
Bell and Gossett Co., Morton Grove, Ill.
Pangborn Corp., Hagerstown, Md.
Riehle Testing Machine Div., American Machine & Metals, Inc., E. Moline, Ill.

CASTINGS—Abrasive Resistant [87]
American Manganese Steel Div., American Brake Shoe Co., Chicago Heights, Ill.
Babcock & Wilcox Co., New York
Blaw-Knox Co., Pittsburgh, Pa.
Dodge Steel Co., Philadelphia
Duraloy Co., Scottdale, Pa.
Fahralloy Co., Harvey, Ill.
International Nickel Co., New York, N. Y.
Lebanon Steel Foundry, Lebanon, Pa.
McCauley Alloy Co., Chicago Hts., Ill.
Meehanite Metal Corp., New Rochelle, N. Y.
Midvale Co., Philadelphia
National-Erie Corp., Erie, Pa.
Ohio Steel Foundry Co., Springfield, O.
Sterling-Alloys, Inc., Woburn, Mass.
Taylor-Wharton Iron & Steel Co., Easton, Pennsylvania and High Bridge, N. J.

CASTINGS—Air Hardening Tool Steel Cast to Shape [88]
H. Boker & Co., Inc., New York
Electric Steel Castings Co., Indianapolis
Forging & Casting Corp., Ferndale, Mich.
Jessop Steel Co., Washington, Pa.
Midvale Co., Nicetown, Philadelphia, Pa.
Sterling Alloys, Inc., Woburn, Mass.

CASTINGS—Alloy Iron [89]
Acme Foundry Co., Detroit
Alten's F'dry & Mach. Wks., Lancaster, Pa.
Amer. Mang. Steel Div., American Brake Shoe Co., Chicago Hts.
Bethlehem Steel Co., Bethlehem, Pa.
Binney Castings Co., Toledo
Blaw-Knox Co., Pittsburgh, Pa.
Bullard-Dunn Process Div., Bullard Co., Bridgeport, Conn.
Carnegie-Illinois Steel Corp., Pgh., Pa.
Chain Belt Co., Milwaukee, Wis.
Chambersburg Eng. Co., Chambersb'g, Pa.
Chicago Hdw. F'dry Co., N. Chicago, Ill.
Chicago Malleable Castings Co., Chicago
Coast Metals, Inc., Canton, O.
Columbia Steel Co., San Francisco, Calif.

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Duriron Co., Inc., Dayton, O.
Farrel-Birmingham Co., Ansonia, Conn.
Forest City F'drys Co., Cleveland
Forging & Casting Corp., Ferndale, Mich.
Chas. E. Francis Co., Rushville, Ind.
General Alloys Co., Boston, Mass.
Greenlee Foundry Co., Chicago
Gunite Foundries Corp., Rockford, Ill.
Mackintosh-Hemphill Co., Pittsburgh
Mahr Manufacturing Co., Minneapolis
Meehanite Metal Corp., New Rochelle, N.Y.
Michiana Prod. Corp., Michigan City, Ind.
Michigan Steel Casting Co., Detroit
Pohlman F'dry Co., Buffalo
Robins Conveyors, Inc., Passaic, N. J.
Sterling-Alloys, Inc., Woburn, Mass.
Western Foundry Co., Chicago, Ill.
Youngstown F'dry & Mach. Co., Youngstown, O.

CASTINGS—Alloy Steel [90]
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Amer. Mang. Steel Div., American Brake Shoe Co., Chicago Hts.
Amer. Steel Casting Co., Newark, N. J.
Atlas F'dry Co., Irvington, N. J.
Babcock & Wilcox Co., New York
Benedict Miller, Inc., Newark, N. J.
Bethlehem Steel Co., Bethlehem, Pa.
Blaw-Knox Co., Pittsburgh, Pa.
Carnegie-Illinois Steel Corp., Pgh., Pa.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Chicago Steel Foundry Co., Chicago, Ill.
Columbia Steel Co., San Francisco, Calif.
Continental Roll & Steel Fdy. Co., East Chicago, Ind.
Cooper Alloy F'dry Co., Hillside, N. J.
Crucible Steel Casting Co., Cleveland
Detroit Steel Casting Co., Detroit
Dodge Steel Co., Philadelphia
Driver-Harris Co., Harrison, N. J.
Duraloy Co., Scottdale, Pa.
Duriron Co., Inc., Dayton, O.
Electric Steel Castings Co., Indianapolis
Electro Alloys Co., Elyria, Ohio
Empire Steel Castings, Inc., Reading, Pa.
Fahralloy Co., Harvey, Ill.
Farrel-Birmingham Co., Ansonia, Conn.
Forging & Casting Corp., Ferndale, Mich.
Ft. Pitt Steel Cstg. Co., McKeesport, Pa.
Lebanon Steel Foundry, Lebanon, Pa.
Mackintosh-Hemphill Co., Pittsburgh
McCauley Alloy Co., Chicago Heights, Ill.
Michiana Prod. Corp., Michigan City, Ind.
Michigan Steel Casting Co., Detroit
National-Erie Corp., Erie, Pa.
Nitralloy Corp., New York
Ohio Steel Foundry Co., Springfield, Ohio
Oklahoma Steel Castings Co., Tulsa
Reading Steel Casting Div., American Chain & Cable Co., Inc., Reading, Pa.
Sivyer Steel Casting Co., Milwaukee
Strong Steel Foundry Co., Buffalo
Symington-Gould Corp., Rochester, N. Y.
Taylor-Wharton Iron & Steel Co., Easton, Pa.
Texas Electric Steel Casting Co., Houston
Unitcast Corp., Toledo, Ohio
Washington Iron Works, Seattle, Wash.
Youngstown Alloy Cstgs. Co., Youngstown

CASTINGS—Aluminum [91]
Aluminum Co. of America, Pittsburgh, Pa.
Aluminum Industries, Inc., Cincinnati
Bohn Aluminum & Brass Corp., Detroit
Bound Brook Oil-Less Bearing Co., Bound Brook, N. J.
A. W. Cadman Mfg. Co., Pittsburgh, Pa.
Cleveland Hdwe. & Forging Co., Cleveland
Dollin Corp., Irvington, N. J.
Frontier Bronze Corp., Niag. Falls, N. Y.
Harvill Corporation, Los Angeles, Calif.
Howard F'dry Co., Chicago
Miller Co., Meriden, Conn.
Monarch Alloys Co., Ravenna, Ohio
Nat'l Bronze & Alum. F'dry Co., Cleveland
National Radiator Co., Johnstown, Pa.
Nicralumin Co., Wilmington, Delaware
Henry Perkins Co., Bridgewater, Mass.
Reynolds Metals Co., Louisville, Ky.
T. Shriver & Co., Inc., Harrison, N. J.
Whip-Mix Corp., Louisville, Ky.

CASTINGS—Beryllium Copper [92]
Ampco Metal, Inc., Milwaukee, Wis.
Beryllium Corp. of Pa., Reading, Pa.
Thomas J. Dee & Co., Chicago
Howard Foundry Co., Chicago
P. R. Mallory & Co., Indianapolis, Ind.
S-M-S Corp., Detroit
Whip-Mix Corp., Inc., Louisville, Ky.

CASTINGS—Brass, Bronze, Copper [93]
Aluminum Co. of America, Pittsburgh, Pa.
American Man. Bronze Co., Philadelphia
Ampco Metal, Inc., Milwaukee, Wis.
Atlas Brass Foundry, Los Angeles, Calif.
Bearium Metals Corp., Rochester, N. Y.
Bethlehem Steel Co., Bethlehem, Pa.
Bound Brook Oil-Less Bearing Co., Bound Brook, N. J.
Bunting Brass & Bronze Co., Toledo, Ohio
A. W. Cadman Mfg. Co., Pittsburgh, Pa.
Chase Brass & Cop. Co., Waterbury, Conn.
Chicago Hdw. F'dry Co., N. Chicago, Ill.
Dole Valve Co., Chicago
Federal-Mogul Corp., Detroit
Frontier Bronze Corp., Niag. Falls, N. Y.
Hammond Brass Works, Hammond, Ind.
Howard F'dry Co., Chicago
Johnson Bronze Co., New Castle, Pa.
Koppers Co., Bartlett Hayward Div., Baltimore, Md.
Lumen Bearing Co., Buffalo
P. R. Mallory & Co., Inc., Indianapolis
Miller & Co., Meriden, Conn.
McGill Mfg. Co., Valparaiso, Ind.
Monarch Alloys Co., Ravenna, Ohio
Mueller Brass Co., Port Huron, Mich.
National Bearing Metals Corp., St. Louis
Ohio Steel Foundry Co., Springfield, Ohio
Henry Perkins Co., Bridgewater, Mass.
S-M-S Corp., Detroit
Shenango-Penn Mold Co., Dover, Ohio
T. Shriver & Co., Inc., Harrison, N. J.
Specialties Mfg. Co., Inc., Bloomfield, N. J.
Tri-Clover Machine Co., Kenosha, Wis.
Whip-Mix Corp., Louisville, Ky.

CASTINGS—Centrifugal [94]
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
American Cast Iron Pipe Co., Birmingham, Ala.
Amer. Steel Castings Co., Newark, N. J.
Ampco Metal, Inc., Milwaukee, Wis.
Bethlehem Steel Co., Bethlehem, Pa.
Blaw-Knox Co., Pittsburgh, Pa.
Bunting Brass & Bronze Co., Toledo, O.
Calorizing Co., Pittsburgh, Pa.
Cooper Alloy F'dry Co., Hillside, N. J.
Duraloy Co., Scottdale, Pa.
Electric Steel Castings Co., Indianapolis
International Nickel Co., New York, N. Y.
Koppers Co., Bartlett Hayward Div., Baltimore, Md.
Lebanon Steel Foundry, Lebanon, Pa.
McGill Mfg. Co., Valparaiso, Ind.
Michiana Prod. Corp., Michigan City, Ind.
Michigan Steel Casting Co., Detroit
Mueller Brass Co., Port Huron, Mich.
National Bearing Metals Corp., St. Louis
Ohio Steel Foundry Co., Springfield, Ohio
Shenango-Penn Mold Co., Dover, Ohio
Standard Alloy Co., Cleveland
Texas Electric Steel Casting Co., Houston
Whip-Mix Corp., Inc., Louisville, Ky.

CASTINGS—Corrosion, Heat Resist. [95]
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Alloy Casting Co., Champaign, Ill.
Alten's F'dry & Mach. Wks., Lancaster, O.
Aluminum Co. of America, Pittsburgh, Pa.
Aluminum Industries, Inc., Cincinnati
Amer. Manganese Bronze Co., Phila.
Amer. Mang. Steel Div., American Brake Shoe Co., Chicago Hts.
Amer. Steel Castings Co., Newark, N. J.
Ampco Metal, Inc., Milwaukee, Wis.
Atlas F'dry Co., Irvington, N. J.
Babcock & Wilcox Co., New York
Bethlehem Steel Co., Bethlehem, Pa.
Binney Castings Co., Toledo
Blaw-Knox Co., Pittsburgh, Pa.
Burgess-Parr Co., Freeport, Ill.
Calorizing Co., Pittsburgh, Pa.
Carnegie-Illinois Steel Corp., Pgh., Pa.
Chicago Steel Foundry Co., Chicago, Ill.
Columbia Steel Co., San Francisco, Calif.
Cooper Alloy Foundry Co., Hillside, N. J.
Crawford & Doherty Foundry Co., Portland, Ore.
Crucible Steel Cstg. Co., Cleveland
Delloy Metals, Philadelphia, Pa.
Driver-Harris Co., Harrison, N. J.
Duraloy Co., Scottdale, Pa.
Duriron Co., Inc., Dayton, O.
Electro Alloys Co., Elyria, Ohio
Empire Steel Castings, Inc., Reading, Pa.
Fahralloy Co., Harvey, Ill.
Farrel-Birmingham Co., Ansonia, Co
Forest City Foundries Co., Cleveland
Frontier Bronze Corp., Niag. Falls, N.
General Alloys Co., Boston, Mass.
Haynes Stellite Co., Kokomo, Ind.
Hoskins Mfg. Co., Detroit, Mich.
International Nickel Co., New York
Lake City Malleable Co., Cleveland, O
Lebanon Steel Foundry, Lebanon, Pa.
Mahr Mfg. Co., Minneapolis, Minn.
Meehanite Res. Inst., New Rochelle, N
Michiana Prod. Corp., Michigan City,
Michigan Steel Casting Co., Detroit
Midvale Co., Nicetown, Philadelphia,
Ohio Steel Foundry Co., Springfield, O
Henry Perkins Co., Bridgewater, Mass
Horace T. Potts Co., Philadelphia, Pa.
Sivyer Steel Castings Co., Milwaukee,
Standard Alloy Co., Cleveland
Sterling Alloys Co., Woburn, Mass.
Symington-Gould Corp., Rochester, N.
Texas Electric Steel Casting Co., Hou
Wall-Colmonoy Corp., Detroit
Youngstown Alloy Cstg. Co., Youngst

CASTINGS—Die [96]
Aluminum Co. of America, Pittsburgh,
American Brass Co., Waterbury, Conn.
Aurora Metal Co., Aurora, Ill.
Beryllium Corp. of Pa., Reading, Pa.
Cleveland Hdwe. & Forging Co., Cleve
Crucible Steel Cstg. Co., Cleveland
Dollin Corp., Irvington, N. J.
Dow Chemical Co., Midland, Mich.
Forest City Foundries Co., Cleveland
Harvill Corporation, Los Angeles, Cal
Lester Engineering Co., Cleveland
Titan Metal Mfg. Co., Bellefonte, Pa.
Whip-Mix Corp., Inc., Louisville, Ky.

CASTINGS—Gray Iron [97]
Acme Foundry Co., Detroit
Alten's F'dry & Mach. Wks., Lancaster
Amer. Car & F'dry Co., New York
Amer. Chain Div., A. C. & C., York, P
Babcock & Wilcox Co., New York
Bethlehem Steel Co., Bethlehem, Pa.
Bullard-Dunn Process Div., Bullard
Bridgeport, Conn.
Carnegie-Illinois Steel Corp., Pgh., P
Chicago Hdwe. F'dry Co., N. Chicago,
Columbia Steel Co., San Francisco, C
Crawford & Doherty Foundry Co., P
land, Ore.
Dow Chemical Co., Midland, Mich.
Farrel-Birmingham Co., Ansonia, Co
Forest City Foundries Co., Cleveland
Chas. E. Francis Co., Rushville, Ind.
General Metals Corp., Los Angeles
Greenlee Foundry Co., Chicago
Gunite Foundries Corp., Rockford, Ill.
Koppers Co., Bartlett Hayward Div.,
timore, Md.
Lancaster Iron Works, Inc., Lancaster
Mackintosh-Hemphill Co., Pittsburgh
Mahr Mfg. Co., Minneapolis, Minn.
Meehanite Metal Corp., New Rochelle,
National Radiator Co., Johnstown, Pa.
Pohlman F'dry Co., Buffalo
Saginaw Malleable Iron Div., G. M.
Saginaw, Mich.
Tenn. Coal, Iron & R. R. Co., Birm.,
W. S. Tyler Co., Cleveland
Union Mfg. Co., New Britain, Conn.
Western Foundry Co., Chicago, Ill.
Youngstown F'dry & Mach. Co., You
town, O.

CASTINGS—Magnesium Alloys [98]
Aluminum Co. of America, Pittsburgh,
Aluminum Industries, Inc., Cincinnati
Amer. Magnesium Corp., Pittsburgh,
Bohn Aluminum & Brass Corp., Detro
Carnegie-Illinois Steel Corp., Pgh., P
Dow Chemical Co., Midland, Mich.
Harvill Corporation, Los Angeles, Cal
Howard Foundry Co., Chicago

CASTINGS—Malleable [99]
Amer. Chain Div., A. C. & C., York, P
Carnegie-Illinois Steel Corp., Pittsburg
Chicago Malleable Castings Co., Chic
General Metals Corp., Los Angeles
Gunite Foundries Corp., Rockford, Ill.
Lake City Malleable Co., Cleveland, O
Saginaw Malleable Iron Div., G. M.
Saginaw, Mich.

**CASTINGS—Oil Hardening Tool S
Cast to Shape [100]**
Allegheny Ludlum Steel Corp., Brack
ridge, Pa.
H. Boker & Co., Inc., New York

See Advertisement of Companies in Bold-Face Type for Further Information

DURASPUN CENTRIFUGAL CASTINGS

CENTRIFUGAL CASTINGS

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1-DU-2

Electric Steel Castings Co., Indianapolis
Forging & Casting Corp., Ferndale, Mich.
Midvale Co., Nicetown, Philadelphia, Pa.

CASTINGS—Pressure [101]
Alten's F'dry & Mach. Wks., Lancaster, O.
Aluminum Co. of America, Pittsburgh, Pa.
American Brass Co., Waterbury, Conn.
Amer. Steel Castings Co., Newark, N. J.
A. W. Cadman Mfg. Co., Pittsburgh, Pa.
Chicago Steel Foundry Co., Chicago, Ill.
Cleveland Hdwe. & Forging Co., Cleveland
Crawford & Doherty Foundry Co., Portland, Ore.
Crucible Steel Cstg. Co., Cleveland
Detroit Steel Casting Co., Detroit
Dodge Steel Co., Philadelphia
Dollin Corp., Irvington, N. J.
Dow Chemical Co., Midland, Mich.
Duraloy Co., Scottdale, Pa.
Ecco High Frequency Elec. Corp., No. Bergen, N. J.
Empire Steel Castings, Inc., Reading, Pa.
Forest City Foundries Co., Cleveland
Ft. Pitt Steel Cstg. Co., McKeesport, Pa.
Greenlee Foundry Co., Chicago
Harvill Corporation, Los Angeles, Calif.
Lebanon Steel Foundry, Lebanon, Pa.
McGill Mfg. Co., Valparaiso, Ind.
Meehanite Res. Inst., New Rochelle, N. Y.
National Radiator Co., Johnstown, Pa.
Ohio Steel Foundry Co., Springfield, Ohio
Henry Perkins Co., Bridgewater, Mass.
Pohlman F'dry Co., Buffalo
Reading Steel Casting Div., American Chain & Cable Co., Inc., Reading, Pa.
Sivyer Steel Castings Co., Milwaukee, Wis.
Symington-Gould Co., Rochester, N. Y.
Texas Electric Steel Casting Co., Houston
Western Foundry Co., Chicago, Ill.

CASTINGS—Semi-Steel [102]
Acme Foundry Co., Detroit
Alten's F'dry & Mach. Wks., Lancaster, O.
Atlas Foundry Co., Irvington, N. J.
Bethlehem Steel Co., Bethlehem, Pa.
Blaw-Knox Co., Pittsburgh, Pa.
Carnegie-Illinois Steel Corp., Pgh., Pa.
Columbia Steel Co., San Francisco, Calif.
Duraloy Co., Scottdale, Pa.
Chas. E. Francis Co., Rushville, Ind.
Greenlee Foundry Co., Chicago
Lancaster Iron Works, Inc., Lancaster, Pa.
Link-Belt Co., Chicago
Mahr Mfg. Co., Minneapolis, Minn.
Henry Perkins Co., Bridgewater, Mass.
Pohlman F'dry Co., Buffalo
Reading Steel Casting Div., American Chain & Cable Co., Inc., Reading, Pa.
Symington-Gould Co., Rochester, N. Y.
Tenn. Coal, Iron & R.R. Co., Birm., Ala.
U. S. Steel Supply Co., Chicago
Western Foundry Co., Chicago, Ill.
Youngstown F'dry & Mach. Co., Youngstown, O.

CASTINGS—Steel [103]
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Amer. Chain & Cable Co., Bridgeport, Conn.
Amer. Mang. Steel Div., American Brake Shoe Co., Chicago Hts.
American Steel Castings Co., Newark
Atlas Foundry Co., Irvington, N. J.
Baldwin Locomotive Works, Phila., Pa.
Bethlehem Steel Co., Bethlehem, Pa.
Blaw-Knox Co., Pittsburgh, Pa.
Burnside Steel Foundry Co., Chicago
Carnegie-Illinois Steel Corp., Pittsburgh
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Chicago Malleable Castings Co., Chicago
Chicago Steel Foundry Co., Chicago, Ill.
Continental Roll & Steel Fdy. Co., East Chicago, Ind.
Crucible Steel Casting Co., Cleveland
Detroit Steel Casting Co., Detroit, Mich.
Dodge Steel Co., Philadelphia
Driver-Harris Co., Harrison, N. J.
Electric Steel Cstgs. Co., Indianapolis
Empire Steel Castings, Inc., Reading, Pa.
Erie Forge Co., Erie, Pa.
Farrel-Birmingham Co., Ansonia, Conn.
Firth-Sterling Steel Co., McKeesport, Pa.
Forging & Casting Corp., Ferndale, Mich.
Ft. Pitt Steel Cstg. Co., McKeesport, Pa.
General Metals Corp., Los Angeles
Gunite Foundries Corp., Rockford, Ill.
Hartford Elec. Steel Corp., Hartford, Conn.
Lebanon Steel F'dry, Lebanon, Pa.
Michigan Steel Casting Co., Detroit
National-Erie Corp., Erie, Pa.
Ohio Steel Foundry Co., Springfield, Ohio
Oklahoma Steel Castings Co., Tulsa
Reading Steel Casting Div., American Chain & Cable Co., Inc., Reading, Pa.
Sivyer Steel Casting Co., Milwaukee
Standard Steel Works Div., Baldwin Locomotive Works, Philadelphia, Pa.
Strong Steel Foundry Co., Buffalo
Symington-Gould Corp., Rochester
Taylor-Wharton Iron & Steel Co., High Bridge, N. J.
Texas Electric Steel Casting Co., Houston
Unitcast Corp., Toledo, O.
Washington Iron Works, Seattle, Wash.
Whip-Mix Corp., Louisville, Ky.
Youngstown Alloy Cstg. Co., Youngstown

CAST IRON—Welding Rods [104]
Air Reduction, New York
Atlas Foundry Co., Irvington, N. J.
Chicago Hdw. & F'dry Co., N. Chicago
Chicago Steel Foundry Co., Chicago, Ill.
Eutectic Welding Alloys, Inc., New York
General Electric Co., Schenectady, N. Y.
Linde Air Products Co., New York
National Cylinder Gas Co., Chicago
Horace T. Potts Co., Philadelphia, Pa.
Jos. T. Ryerson & Son, Inc., Chicago
U. S. Steel Supply Co., Chicago
Universal Power Corp., Cleveland
Westinghouse Elec. & Mfg. Co., E. Pgh.
Youngstown Alloy Cstg. Co., Youngstown

CEMENT—Refractory [105]
American Crucible Co., Shelton, Conn.
Amer. Gas Furnace Co., Elizabeth, N. J.
Armstrong Cork Co., Lancaster, Pa.
Atlas Mineral Prod. Co., Mertztown, Pa.
Babcock & Wilcox Co., New York
Botfield Refractories Co., Philadelphia
Brickseal Refractory Co., Hoboken, N. J.
Carborundum Co., Perth Amboy, N. J.
Philip Carey Mfg. Co., Lockland, O.
Case Hardening Service Co., Cleveland
Chicago Retort & Fire Brick Co., Chicago
Cleveland Quarries Co., Cleveland
Corhart Refractories Co., Louisville
Electro Refract. & Alloys Corp., Buffalo
Federal Refractories Corp., Akron, O.
Fisher Furnace Co., Chicago, Ill.
Foote Mineral Co., Philadelphia
Foundry Services, Inc., New York City
Claud S. Gordon Co., Chicago, Ill.
Harbison-Walker Refrac. Co., Pgh., Pa.
A. F. Holden Co., New Haven, Conn.
Ironton Fire Brick Co., Ironton, O.
Johns-Manville, New York
M. W. Kellogg Co., Jersey City, N. J.
Laclede-Christy Clay Prod. Co., St. Louis
McLeod & Henry Co., Troy, N. Y.
North Amer. Refractories Co., Cleveland
Norton Co., Worcester, Mass.
Park Chemical Co., Detroit
Plibrico Jointless Firebrick Co., Chicago
Quigley Co., Inc., New York
Ramtite Co., Chicago
Refractory & Insulation Corp., New York
F. E. Schundler & Co., Inc., Long Island City, N. Y.
Standard Fuel Engineering Co., Detroit
Chas. Taylor Sons Co., Cincinnati, O.
Titanium Alloy Mfg. Co., Niagara Falls
Universal Atlas Cement Co., New York
Wahl Refractory Prod. Co., Fremont, Ohio

CHAINS—Heat Resistant [106]
Alloy Casting Co., Champaign, Ill.
American Chain Div., American Chain & Cable Co., Inc., York, Pa.
Amer. Mang. Steel Div., American Brake Shoe Co., Chicago Hts.
Chain Belt Co., Milwaukee, Wis.
Chicago Steel Foundry Co., Chicago, Ill.
Driver-Harris Co., Harrison, N. J.
Duraloy Co., Scottdale, Pa.
Electro Alloys Co., Elyria, Ohio
Fahralloy Co., Harvey, Ill.
General Alloys Co., Boston, Mass.
Hoskins Mfg. Co., Detroit, Mich.
Jeffrey Mfg. Co., Columbus, Ohio
Link-Belt Co., Indianapolis
Manganese Steel Forge Co., Philadelphia
Michiana Prod. Corp., Michigan City, Ind.
Michigan Steel Casting Co., Detroit
Ohio Steel Foundry Co., Springfield, Ohio
Palmer-Bee Co., Detroit
Jos. T. Ryerson & Son, Inc., Chicago
Standard Alloy Co., Cleveland
Sterling-Alloys, Inc., Woburn, Mass.
Tate-Jones & Co., Inc., Leetsdale, Pa.

CHEMICALS—Electroplating [107]
Alrose Chemical Co., Providence, R. I.
Amer. Cyan. & Chem. Corp., New York
Cowles Detergent Co., Cleveland
Crown Rheostat & Supply Co., Chicago
Thomas J. Dee & Co., Chicago
E. I. du Pont de Nemours & Co., Wilmington, Del.
Enthone Co., New Haven, Conn.
Fidelity Chemical Prod. Corp., Newark
Harshaw Chemical Co., Cleveland
Indium Corp. of America, New York
W. D. MacDermid Chem. Co., Bristol, Co
MacDermid, Inc., Waterbury, Conn.
Mercury Chemical Co., Inc., Detroit
Monsanto Chemical Co., St. Louis, Mo
Mutual Chem. Co. of America, New Y
Pennsylvania Salt Mfg. Co., Philadelp
Philadelphia Quartz Co., Philadelphia,
Powder Metals & Alloys, Inc., New Yor
Special Chemicals Corp., New York
Turco Products, Inc., Los Angeles
United Chromium, Inc., New York

CHEMICALS—Industrial [108]
Aluminum Co. of America, Pittsburgh
Amer. Cyan. & Chem. Corp., New York
Burrell Technical Supply Co., Pittsbur
Carbide & Carb. Chem. Corp., New Y
Char Products Co., Indianapolis, Ind.
Chicago Steel Foundry Co., Chicago, I
Cowles Detergent Co., Cleveland
E. I. du Pont de Nemours & Co., Wilmington, Del.
Fidelity Chemical Prod. Corp., Newark
Foote Mineral Co., Philadelphia
Glyco Products Co., Inc., Brooklyn, N
Charles Hardy, Inc., New York
Harshaw Chemical Co., Cleveland
A. F. Holden Co., New Haven, Conn.
Hooker Electrochemical Co., Niagara F
Kali Mfg. Co., Philadelphia, Pa.
Kelite Products, Inc., Los Angeles
Koppers Co., Pittsburgh
W. D. MacDermid Chem. Co., Bristol, Co
MacDermid, Inc., Waterbury, Conn.
Mathieson Alkali Works, New York
Metalloy Products Co., Los Angeles, C
Mitchell Bradford Chemical Co., Bridgeport, Conn.
Molybdenum Corp. of Amer., Pittsbu
Monsanto Chemical Co., Merrimac D Everett, Mass.
Mutual Chem. Co. of America, New Y
Park Chemical Co., Detroit, Mich.
Pennsylvania Salt Mfg. Co., Philadelp
Pfaltz & Bauer, Inc., New York
Philadelphia Quartz Co., Philadelphia
Pitt. Plate Glass Co., Columbia Chem Div., Pittsburgh
Powder Metals & Alloys, Inc., New Yo
Rex Oil & Chemical Co., Cleveland
G. S. Rogers & Co., Chicago, Ill.
Turco Products, Inc., Los Angeles

CHROME REFRACTORIES [109]
Basic Refractories, Inc., Cleveland
Botfield Refractories Co., Philadelphia
Farrar Ind. Prod. Co., Los Angeles, Ca
Federal Refractories Corp., Akron, O.
General Refractories Co., Philadelphia
Harbison-Walker Refractories Co., Pgh
Johns-Manville, New York
Laclede-Christy Clay Prod. Co., St. Lo
Park Chemical Co., Detroit
Quigley Co., Inc., New York
Standard Fuel Engineering Co., Detroi

CHROMIUM—Metals & Alloys [110]
Alloy Casting Co., Champaign, Ill.
Amer. Mang. Steel Div., Amer. Brake S Co., Chicago Hts., Ill.
G. O. Carlson, Inc., Thorndale, Pa.
Carpenter Steel Co., Reading, Pa.
Chicago Steel Foundry Co., Chicago, Ill
Chromium Min. & Smelt. Corp., Monte
Cooper Alloy F'dry Co., Hillside, N. J.
Gilbert Cummins & Co., Baltimore, M
Driver-Harris Co., Harrison, N. J.
Wilbur B. Driver Co., Newark, N. J.
Electro Metallurgical Co., New York
Firth-Sterling Steel Co., McKeesport,
Foote Mineral Co., Philadelphia
Peter A. Frasse & Co., Inc., New York
General Alloys Co., Boston, Mass.
Hoskins Mfg. Co., Detroit, Mich.
Joslyn Mfg. & Supply Co., Ft. Wayne, I
Lincoln Park Tool & Gage Co., Linc Park, Mich.
MacDermid, Inc., Waterbury, Conn.
Metal & Thermit Corp., New York
Metallurgical Products Co., Philadelph
Michigan Steel Casting Co., Detroit
Miller & Co., Chicago
Niagara Falls Smelting & Ref. Co., Buff
Ohio Ferro Alloys Corp., Canton, Ohio
Ohio Steel Foundry Co., Springfield, O

burgh Metallurgical Co., Niagara Falls
stless Iron & Steel Corp., Balt., Md.
adium Corp. of America, New York

AD STEELS—See **Steels**

LEANERS—Metal [111]
er. Cyanamid & Chem. Corp., New York
lard-Dunn Process Div., Bullard Co., Bridgeport, Conn.
rbide & Carb. Chem. Corp., New York
ro Products Co., Cleveland
ecial Alloys Co., Philadelphia
k's Patent Fire Arms, Hartford, Conn.
rles Detergent Co., Cleveland
own Rheostat & Supply Co., Chicago
trex Corp., Detroit
I. du Pont de Nemours & Co., Wilmington, Del.
ro Chemical Corp., Weehawken, N. J.
chone Co., New Haven, Conn.
rrar Ind. Prod. Co., Los Angeles, Calif.
delity Chemical Prod. Corp., Newark
derick Gumm Chem. Co., Kearny, N. J.
athath Corp., Springfield, Mass.
F. Holden Co., New Haven, Conn.
F. Houghton & Co., Philadelphia, Pa.
h Mfg. Co., Philadelphia, Pa.
lite Products, Inc., Los Angeles
W. Kelley Co., Cleveland, Ohio
embs & Co., Chicago
D MacDermid Chem. Co., Bristol, Conn.
acDermid, Inc., Waterbury, Conn.
gnus Chemical Co., Garwood, N. J.
gnuson Prods. Corp., Brooklyn
tchless Metal Polish Co., Chicago
thieson Alkali Works, New York
rcury Chemical Co., Inc., Detroit
tchell-Bradford Chemical Co., Bridgeport, Conn.
tional Graphite Co., New York
tional Metal Abrasive Co., Cleveland
tional Oil Products Co., Harrison, N. J.
kite Products, Inc., New York
rborn Corp., Hagerstown, Md.
rk Chemical Co., Detroit, Mich.
nnsylvania Salt Mfg. Co., Philadelphia
iladelphia Quartz Co., Philadelphia
illips Manufacturing Co., Chicago
ritan Mfg. Co., Waterbury, Conn.
aker Chemical Products Corp., Conshohocken, Pa.
igley Co., Inc., New York
x Oil & Chemical Co., Cleveland
ehle Testing Machine Div., American Machine & Metals, Inc., E. Moline, Ill.
mford Chem. Wks., Rumford, R. I.
monix Co., Chicago, Ill.
ventol Chemical Products, Inc., Detroit
ecial Chemicals Corp., New York
rco Products, Inc., Los Angeles
arren Ref. & Chem. Co., Cleveland
. S. Steel Supply Co., Chicago

LEANING EQUIPMENT—Metal [112]
roil Burner Co., Inc., W. New York, N. J.
ey-Ferguson Co., Cincinnati, Ohio
ner. Fdry Equip. Co., Mishawaka, Ind.
. S. Blakeslee & Co., Chicago, Ill.
llard-Dunn Process Div., Bullard Co., Bridgeport, Conn.
ro Products Co., Cleveland
lt's Patent Fire Arms Mfg. Co., Hartford, Conn.
ntinental Industrial Eng., Inc., Chicago
trex Corp., Detroit
eisbach Engr. Corp., Yonkers, N. Y.
lipse Fuel & Eng. Co., Rockford, Ill.
el & Co., Cleveland
ward Engrg. & Mfg. Co., Cincinnati
acDermid, Inc., Waterbury, Conn.
alwash Machinery Co., Irvington, N. J.
wcomb-Detroit Co., Detroit
born Mfg. Co., Cleveland, Ohio
ngborn Corp., Hagerstown, Md.
rsons Engr. Corp., Cleveland, Ohio
illips Manufacturing Co., Chicago
. Ransohoff, Inc., Cincinnati, Ohio
. S. Rockwell Co., New York
lem Engineering Co., Salem, Ohio
lventol Chemical Products, Inc., Detroit
rederic B. Stevens, Inc., Detroit
ate-Jones & Co., Inc., Leetsdale, Pa.
olhurst Centrifugal Div., Amer. Mach. & Metals, Inc., E. Moline, Ill.
. S. Galvanizing & Plating Equipment Corp., Brooklyn, N. Y.

LEANING EQUIPMENT (METAL)—Electro-Chemical [113]
. S. Blakeslee & Co., Chicago
ew-Knox Co., Pittsburgh, Pa.
llard-Dunn Process Div., Bullard Co., Bridgeport, Conn.
Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.
Continental Industrial Eng., Inc., Chicago
Crown Rheostat & Supply Co., Chicago
Heil & Co., Cleveland
MacDermid, Inc., Waterbury, Conn.
Magnus Chemical Co., Garwood, N. J.
Meaker Co., Chicago
Osborn Mfg. Co., Cleveland, Ohio
Phillips Manufacturing Co., Chicago
Riehle Testing Machine Div., American Machine & Metals, Inc., E. Moline, Ill.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Tivit Products, Inc., Los Angeles, Calif.

CLOTH—Wire [114]
Audubon Wire Cloth Corp., Philadelphia
Buffalo Wire Works Co., Buffalo
Cambridge Wire Cloth Co., Cambridge, Md.
Cyclone Fence Div., Amer. Steel & Wire Co., Waukegan, Ill.
Jeffrey Mfg. Co., Columbus, Ohio
C. O. Jelliff Mfg. Corp., Southport, Conn.
Logan Co., Louisville
Ludlow-Saylor Wire Co., St. Louis
Newark Wire Cloth Co., Newark, N. J.
Rolock, Inc., Fairfield, Conn.
W. S. Tyler Co., Cleveland
Whitehead Metal Products Co., New York
Wickwire Bros., Inc., Cortland, N. Y.

COILS—Cold & Hot Rolled [115]
Aluminum Co. of America, Pittsburgh
American Brass Co., Waterbury, Conn.
Amer. Steel & Wire, Cleveland, Ohio
Carnegie-Illinois Steel Corp., Pittsburgh
Columbia Steel Co., San Francisco, Calif.
Follansbee Steel Corp., Pittsburgh, Pa.
Inland Steel Co., Chicago
Republic Steel Corp., Cleveland, Ohio
Reynolds Metals Co., Louisville, Ky.
Stanley Works, New Britain, Conn.
Tenn. Coal, Iron & R. R. Co., Birm., Ala.
U. S. Supply Co., Chicago
Univ.-Cyclops Steel Corp., Bridgeville, Pa.

COLUMBIUM ALLOYS [116]
Chicago Steel Foundry Co., Chicago, Ill.
Electro Metallurgical Co., New York
General Alloys Co., Boston, Mass.
Lebanon Steel Foundry, Lebanon, Pa.

COMBUSTION CONTROLS [117]
Am. Gas Furnace Co., Elizabeth, N. J.
Bailey Meter Co., Cleveland
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Chicago Flexible Shaft Co., Chicago
Eclipse Fuel Eng'ing Co., Rockford, Ill.
Flinn & Dreffein Co., Chicago, Ill.
General Controls Co., Glendale, Calif.
Hays Corp., Michigan City, Ind.
Leeds & Northrup Co., Philadelphia, Pa.
Maxon Premix Burner Co., Muncie, Ind.
Nat'l Machine Works, Chicago
Selas Co., Philadelphia, Pa.
Surface Combustion, Toledo
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia, Pa.
Wheelco Instruments Co., Chicago, Ill.

COMBUSTION TUBES [118]
Alloy Mfg. Co., Inc., Pittsburgh, Pa.
Baker & Co., Newark, N. J.
Burrell Technical Supply Co., Pittsburgh
Carborundum Co., Niagara Falls, N. Y.
Chicago Steel Foundry Co., Chicago, Ill.
Harry W. Dietert Co., Detroit, Mich.
Eberbach & Son Co., Ann Arbor, Mich.
Electro Ref. & Alloys Corp., Buffalo
Fisher Scientific Co., Pittsburgh
General Alloys Co., Boston, Mass.
Claud S. Gordon Co., Chicago, Ill.
Hevi Duty Electric Co., Milwaukee, Wis.
C. M. Kemp Mfg. Co., Baltimore, Md.
Michigan Steel Casting Co., Detroit
Norton Co., Worcester, Mass.
Ohio Steel Foundry Co., Springfield, O.
Pressed Steel Co., Wilkes-Barre, Pa.
E. H. Sargent & Co., Chicago, Ill.
Sentry Co., Foxboro, Mass.
Surface Combustion, Toledo, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.

COMPOUNDS—Burnishing, Tumbling [119]
Fidelity Chemical Prod. Corp., Newark
Lea Mfg. Co., Waterbury, Conn.
MacDermid, Inc., Waterbury, Conn.
Magnus Chem. Co., Inc., Garwood, N. J.
Magnuson Prods. Corp., Brooklyn
National Oil Products Co., Harrison, N. J.
Puritan Mfg. Co., Waterbury, Conn.
Sturgis Prod. Co., Sturgis, Mich.
Warren Ref. & Chem. Co., Cleveland

COMPOUNDS—Drawing, Cutting [120]
Acheson Colloids Corp., Port Huron, Mich.
Alox Co., Niagara Falls, N. Y.
F. E. Anderson Oil Co., Portland, Conn.
Bell & Gossett Co., Morton Grove, Ill.
Bellis Heat Treating Co., Branford, Conn.
Carbide & Carbon Chem. Corp., New York
C. H. Clark Oil Co., Cleveland
Farrar Ind. Prod. Co., Los Angeles, Calif.
Fidelity Chemical Prod. Corp., Newark
Fiske Bros. Refining Co., Newark, N. J.
Glyco Products Co., Inc., Brooklyn, N. Y.
E. F. Houghton & Co., Philadelphia, Pa.
J. W. Kelley Co., Cleveland, Ohio
Keystone Lubricating Co., Philadelphia
MacDermid, Inc., Waterbury, Conn.
National Oil Products Co., Harrison, N. J.
Oakite Products, Inc., New York
Pure Oil Co., Chicago
Quaker Chemical Products Corp., Conshohocken, Pa.
Rex Oil & Chemical Co., Cleveland
G. S. Rogers & Co., Chicago, Ill.
Standard Oil Co., (Ind.), Chicago
D. A. Stuart & Co., Chicago, Ill.
Suflo, Inc., Elizabeth, N. J.
United Industrial Products, Inc., Elizabeth, N. J.
Warren Ref. & Chem. Co., Cleveland

COMPOUNDS—Lapping [121]
Adolph I. Buehler, Chicago, Ill.
Carbide & Carbon Chem. Corp., New York
Carborundum Co., Niagara Falls, N. Y.
Harrison & Co., Haverhill, Mass.
E. F. Houghton & Co., Philadelphia, Pa.
MacDermid, Inc., Waterbury, Conn.
Matchless Metal Polish Co., Chicago
Minn. Mining & Mfg. Co., St. Paul
Nat'l Oil Products Co., Harrison, N. J.
Suflo, Inc., Elizabeth, N. J.
United Industrial Products, Inc., Elizabeth, N. J.

COMPOUNDS—Soldering and Welding [122]
Air Reduction, New York
Kelite Products, Inc., Los Angeles
Krembs & Co., Chicago
Whitehead Metal Products Co., New York

COMPRESSORS—Air and Gas [123]
Amer. Gas Furnace Co., Elizabeth, N. J.
Beach Russ Co., New York
Binks Mfg. Co., Chicago, Ill.
Brunner Mfg. Co., Utica, N. Y.
Campbell-Hausfeld Co., Harrison, Ohio
DeLaval Steam Turbine Co., Trenton, N. J.
DeVilbiss Co., Toledo
Ingersoll-Rand Co., New York
C. M. Kemp Mfg. Co., Baltimore, Md.
Nat'l Machine Works, Chicago
Paasche Airbrush Co., Chicago
Quincy Compressor Co., Quincy, Ill.
W. S. Rockwell Co., New York
Roots-Connersville Blower Corp., Connersville, Ind.
Spencer Turbine Co., Hartford, Conn.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Worthington Pump & Machinery Corp., Harrison, N. J.

CONTACTS—Electrical [124]
Amer. Electro Metal Corp., Yonkers, N. Y.
Bell & Gossett Co., Chicago, Ill.
C. S. Brainin Div., New York City
Callite Tungsten Corp., Union City, N. J.
W. M. Chace Co., Detroit
Fansteel Met. Corp., No. Chicago, Ill.
Firth-Sterling Steel Co., McKeesport, Pa.
Gibson Electric Co., Pittsburgh, Pa.
Hercules Elec. & Mfg. Co., Brooklyn
P. R. Mallory & Co., Indianapolis, Ind.
National Carbon Co., Inc., Cleveland
National Carbon Co., Inc., New York
Permo Products Corp., Chicago
U. S. Graphite Co., Saginaw, Mich.
H. A. Wilson Co., Newark, N. J.

CONTOUR MEASURING PROJECTORS [125]
Bausch & Lomb Opt. Co., Rochester, N. Y.
Engineers Specialties Div., Cleveland
Engineers Specialties Div., Buffalo
Adam Hilger, Ltd., London, England
Jarrell-Ash Co., Boston, Mass.
George Scherr Co., New York, N. Y.
Carl Zeiss, Inc., New York

CONTROL SYSTEMS—Temp. [126]
Amer. Gas Furnace Co., Elizabeth, N. J.
Automatic Temp. Control Co., Inc., Phila.
Barber-Colman Co., Rockford, Ill.
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.

Burling Instrument Co., Newark, N. J.
Burrell Technical Supply Co., Pittsburgh
Chicago Flexible Shaft Co., Chicago
R. W. Cramer Co., Inc., Centerbrook, Conn.
Charles Englehard, Inc., Newark, N. J.
Foxboro Co., Foxboro, Mass.
General Controls Co., Glendale, Calif.
General Electric Co., Schenectady, N. Y.
Heatbath Corp., Springfield, Mass.
Leeds & Northrup Co., Philadelphia, Pa.
MacDermid, Inc., Waterbury, Conn.
Charles A. Martin Co., Chicago
Maxon Premix Burner Co., Muncie, Ind.
Nat'l Machine Works, Chicago
Parker-Kalon Corp., New York
Partlow Corp., New Hartford, N. Y.
Arklay S. Richards Co., Inc., Newton Highlands, Mass.
Sarco Co., New York
Thwing-Albert Inst. Co., Philadelphia
Harold E. Trent Co., Philadelphia, Pa.
Upton Elec. Salt Bath Furn. Co., Detroit
Vulcan Corp., Philadelphia, Pa.
Wheelco Instruments Co., Chicago, Ill.

CONTROLLED ATMOSPHERE DRYERS [127]
Continental Ind. Engrs. Inc., Chicago
Electric Furnace Co., Salem, O.
C. M. Kemp Mfg. Co., Baltimore, Md.
Niagara Blower Co., New York
Pittsburgh Lectrodryer Corp., Pittsburgh
W. S. Rockwell Co., New York
J. O. Ross Engineering Corp., New York
Salem Engineering Co., Salem, Ohio
Sargent & Wilbur, Pawtucket, R. I.
F. J. Stokes Machine Co., Philadelphia, Pa.
Sweden Freezer Mfg. Co., Seattle, Wash.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Westinghouse Elec. & Mfg. Co., E. Pgh.

CONTROLLERS—Electric [128]
Allis-Chalmers Mfg. Co., Milwaukee
Automatic Temp. Control Co., Inc., Phila.
Barber-Colman Co., Rockford, Ill.
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Burling Instrument Co., Newark, N. J.
Clark Controller Co., Cleveland, O.
Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.
Cutler-Hammer, Inc., Milwaukee
Elec. Controller & Mfg. Co., Cleveland
Fischer & Porter Co., Hatboro, Pa.
Foxboro Co., Foxboro, Mass.
General Controls Co., Glendale, Calif.
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago, Ill.
Leeds & Northrup Co., Philadelphia, Pa.
Lindberg Engineering Co., Chicago
Charles A. Martin Co., Chicago
Maxon Premix Burner Co., Muncie, Ind.
Arklay S. Richards Co., Inc., Newton Highlands, Mass.
C. J. Tagliabue Mfg. Co., Brooklyn, N. Y.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia, Pa.
Westinghouse Elec. & Mfg. Co., E. Pgh.
Wheelco Inst. Co., Chicago, Ill.

CONTROLLERS—Pneumatic [129]
Bailey Meter Co., Cleveland
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Fischer & Porter Co., Hatboro, Pa.
Foxboro Co., Foxboro, Mass.
Leeds & Northrup Co., Philadelphia, Pa.
Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
C. J. Tagliabue Mfg. Co., Brooklyn, N. Y.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Taylor Instrument Co's., Rochester, N. Y.
Vulcan Corp., Philadelphia, Pa.

CONVEYOR BELTS [130]
Alloy Casting Co., Champaign, Ill.
Alvey-Ferguson Co., Cincinnati, O.
Audubon Wire Cloth Corp., Philadelphia
Chicago Steel Foundry Co., Chicago, Ill.
Cyclone Fence Div., Amer. Steel & Wire Co., Waukegan, Ill.
Electro Alloys Co., Elyria, Ohio
General Alloys Co., Boston, Mass.
B. F. Goodrich Co., Akron, Ohio
Jeffrey Mfg. Co., Columbus, Ohio
Manhattan Rubber Mfg. Div., Raybestos-Manhattan, Inc., Passaic, N. J.
Michigan Steel Casting Co., Detroit
Robins Conveyors, Inc., Passaic, N. J.
Sandvik Steel, Inc., New York City
Sterling-Alloys, Inc., Woburn, Mass.
Vulcan Corp., Philadelphia, Pa.
Wickwire Spencer Steel Co., New York

CONVEYORS [131]
Alloy Casting Co., Champaign, Ill.
Alvey-Ferguson Co., Cincinnati, Ohio
C. O. Bartlett & Snow Co., Cleveland
Bellis Heat Treat. Co., Branford, Conn.
Chain Belt Co., Milwaukee, Wis.
Cleve. Crane & Eng. Co., Wickliffe, Ohio
A. B. Farquhar Co., York, Pa.
Fostoria Pressed Steel Corp., Fostoria, O.
General Alloys Co., Boston, Mass.
Industrial Oven Engrg. Co., Cleveland
Jeffrey Mfg. Co., Columbus
Lancaster Iron Works, Inc., Lancaster, Pa.
Link-Belt Co., Chicago
Logan Co., Louisville
Mahr Mfg. Co., Minneapolis, Minn.
Morrison Engineering Corp., Cleveland
Palmer-Bee Co., Hamtramck, Mich.
Parsons Engr. Corp., Cleveland, Ohio
Robins Conveyors, Inc., Passaic, N. J.
Sterling-Alloys, Inc., Woburn, Mass.
Tate-Jones & Co., Inc., Leetsdale, Pa.

COOLERS—Cast Iron [132]
Bell & Gossett Co., Chicago, Ill.
Claud S. Gordon Co., Chicago, Ill.
Griscom-Russell Co., New York

COPPER—Welding Rods [133]
Air Reduction, New York
American Brass Co., Waterbury, Conn.
Ampco Metal, Inc., Milwaukee, Wis.
Bridgeport Brass Co., Bridgeport, Conn.
Eutectic Welding Alloys, Inc., N. Y., N. Y.
Krembs & Co., Chicago
Lincoln Electric Co., Cleveland
National Cylinder Gas Co., Chicago
Revere Copper & Brass, Inc., New York
Universal Power Corp., Cleveland
Whitehead Metal Products Co., New York

CRUCIBLES [134]
Electro Refractories & Alloys Corp., Buffalo
National Carbon Co., Inc., Cleveland
National Carbon Co., Inc., New York

CUTTING MACH.—Oxy-Acetylene [135]
Air Reduction, New York
Brown-Wales Co., Boston, Mass.
Harris Calorific Co., Cleveland, Ohio
Linde Air Products Co., New York
Modern Engineering Co., St. Louis, Mo.
National Cylinder Gas Co., Chicago, Ill.
Tolman Mfg. Co., Boston, Mass.
Universal Power Corp., Cleveland

CUTTING-OFF MACHINES [136]
American Inst. Co., Silver Spring, Md.
Beals-McCarthy & Rogers, Inc., Buffalo
A. I. Buehler, Chicago, Ill.
Andrew C. Campbell Div., A. C. & C. Co., Inc., Bridgeport, Conn.
Catskill Metal Wks., Inc., Catskill, N. Y.
Challenge Machinery Co., Grand Haven, Mich.
Cincinnati Elec. Tool Co., Cincinnati, O.
Continental Machines, Inc., Minneapolis
A. P. DeSanno & Son, Phoenixville, Pa.
DeWalt Products Corp., Lancaster, Pa.
Heller Machine Co., New York, N. Y.
Hydropress, Inc., New York City
Johnson Mfg. Corp., New York
Lewis Machinery Co., Cleveland
Modern Mach. Tool Co., Jackson, Mich.
Pines Engineering Co., Aurora, Ill.
Rasmussen Mach. Co., Racine, Wis.
J. A. Richards Co., Kalamazoo, Mich.
George Scherr Co., Inc., New York
F. B. Shuster Co., New Haven, Conn.
Sterling Grinding Wheel Div., Cleveland Quarries Co., Tiffin, Ohio
Tabor Manufacturing Co., Philadelphia
Yoder Co., Cleveland

CUTTING-OFF WHEELS [137]
Abrasive Co., Philadelphia
Amer. Emery Wheel Wks., Providence, R. I.
Amer. Instrument Co., Silver Spring, Md.
Beals-McCarthy & Rogers, Inc., Buffalo
Bethlehem Steel Co., Bethlehem, Pa.
A. I. Buehler, Chicago, Ill.
Carborundum Co., Niagara Falls, N. Y.
A. P. DeSanno & Son, Phoenixville, Pa.
Electro Ref. & Alloys Corp., Buffalo
Manhattan Rubber Mfg. Div., Raybestos-Manhattan, Inc., Passaic, N. J.
Master Tool Co., Inc., Cleveland
Mico Instrument Co., Cambridge, Mass.
Norton Co., Worcester, Mass.
West Co., Inc., Philadelphia, Pa.

CUTTING OILS—Soluble [138]
Acheson Colloids Corp., Port Huron, Mich.
Alox Corp., Niagara Falls, N. Y.
F. E. Anderson Oil Co., Portland, Conn.
Beals-McCarthy & Rogers, Inc., Buffalo
Cities Service Oil Co., New York
Farrar Ind. Prod. Co., Los Angeles, C
Fidelity Chemical Prod. Corp., New
Fiske Bros. Refining Co., Newark, N. J.
E. F. Houghton & Co., Philadelphia,
Keystone Lubricating Co., Philadel
J. W. Kelley Co., Cleveland
National Graphite Co., New York
Nat'l Oil Products Co., Harrison, N.
Oakite Products, Inc., New York
Penola, Inc., Pittsburgh
Pure Oil Co., Chicago
Quaker Chemical Prod. Corp., Conshocken, Pa.
Rex Oil & Chemical Co., Cleveland
G. S. Rogers & Co., Chicago
Shell Oil Co., New York
Socony-Vacuum Oil Co., New York
Standard Oil Co., Chicago, Ill.
D. A. Stuart & Co., Chicago, Ill.
Sufio, Inc., Elizabeth, N. J.
Sun Oil Co., Philadelphia, Pa.
Swan Finch Oil Corp., New York, N.
United Industrial Products, Inc., Elizabeth, N. J.
Warren Ref. & Chem. Co., Cleveland

CUTTING OILS—Sulphurized [139]
F. E. Anderson Oil Co., Portland, Conn.
Beals-McCarthy & Rogers, Inc., Buffalo
Cities Service Oil Co., New York
C. H. Clark Oil Co., Cleveland
Farrar Ind. Prod. Co., Los Angeles, C
Fiske Bros. Refining Co., Newark, N. J.
Gulf Oil Co., Pittsburgh
Gulf Refining Co., Pittsburgh
E. F. Houghton & Co., Philadelphia, Pa.
J. W. Kelley Co., Cleveland, Ohio
Keystone Lubricating Co., Philadelphia
National Graphite Co., New York
Nat'l Oil Products Co., Harrison, N. J.
Penola, Inc., Pittsburgh
Pure Oil Co., Chicago
Quaker Chemical Products Corp., Conshocken, Pa.
Rex Oil & Chemical Co., Cleveland
G. S. Rogers & Co., Chicago
Shell Oil Co., New York
Socony-Vacuum Oil Co., New York
Standard Oil Co., Chicago, Ill.
D. A. Stuart Oil Co., Ltd., Chicago
Sufio, Inc., Elizabeth, N. J.
Sun Oil Co., Philadelphia, Pa.
Swan Finch Oil Corp., New York, N.
United Industrial Products, Inc., Elizabeth, N. J.
Warren Ref. & Chem. Co., Cleveland

CYANIDES [140]
Amer. Cyanamid & Chem. Corp., New Y
E. I. du Pont de Nemours & Co., I Wilmington, Dela.
MacDermid, Inc., Waterbury, Conn.

CYLINDERS—High Pressure [141]
Hannifin Manufacturing Co., Chicago
Hydro-Power Systems, Inc., Mt. Gilead,
Tate-Jones & Co., Inc., Leetsdale, Pa.
Taylor-Wharton Iron & Steel Co., East Pennsylvania and High Bridge, N.

DEGASSERS—Ferrous & Non-Ferrous [142]
Detrex Corp., Detroit
Electro Ref. & Alloys Corp., Buffalo
Foote Mineral Co., Philadelphia
Foundry Services, Inc., New York Cit
Metallurgical Products Co., Philadelph
Niagara Falls Smelting & Ref. Co., Buf
Tate-Jones & Co., Inc., Leetsdale, Pa.

DEGREASING MACHINERY [143]
Amer. Fdry. Equip. Co., Mishawaka, I
Bell & Gossett Co., Morton Grove, Ill.
G. S. Blakeslee Co., Chicago
Circo Products Co., Cleveland
Crown Rheostat & Supply Co., Chic
Detrex Corp., Detroit
Farrar Ind. Prod. Co., Los Angeles, C
Howard Engr. & Mfg. Co., Cincinnati
MacDermid, Inc., Waterbury, Conn.
Magnus Chemical Co., Garwood, N. J.
Phillips Mfg. Co., Chicago, Ill.
N. Ransohoff, Inc., Cincinnati, Ohio
Riehle Testing Machine Div., Americ Machine & Metals, Inc., E. Moline,
Solventol Chemical Products, Inc., Det
Tate-Jones & Co., Inc., Leetsdale, Pa.
Tivit Products, Inc., Los Angeles, Cal
Tolhurst Centrifugal Equip. Div., Am Mach. and Metals, Inc., E. Moline,

DESCALING [144]
Air Reduction, New York
Ajax Electrothermic Corp., Trenton, N.

er. Fdry Equip. Co., Mishawaka, Ind.
is Heat Treat. Co., Branford, Conn.
ard-Dunn Process Div., Bullard Co., Bridgeport, Conn.
esbach Engr. Corp., Yonkers, N. Y.
hone Co., New Haven, Conn.
ngelman's Heat Treating Hardening Works, Inc., New York
F. Holden Co., New Haven, Conn.
ite Products, Inc., Los Angeles
reside Steel Improv. Co., Cleveland
man Bros., Newark, N. J.
de Air Products Co., New York
-Dermid, Inc., Waterbury, Conn.
tional Cylinder Gas Co., Chicago, Ill.
ite Products, Inc., New York
rborn Corp., Hagerstown, Md.
Ransohoff, Inc., Cincinnati, Ohio
te-Jones & Co., Inc., Leetsdale, Pa.
rco Products, Inc., Los Angeles
rthington Pump & Machinery Corp., Harrison, N. J.

SULPHURIZERS [145]

AL INDICATORS—Precision Measuring [146]

derson & Sons, Westfield, Mass.
stol Co., Waterbury, Conn.
wn Instrument Co., Philadelphia, Pa.
mbridge Instrument Co., Inc., New York
rbanks, Morse & Co., Chicago
deral Products Corp., Providence, R. I.
xboro Co., Foxboro, Mass.
tham Instrument Co., New York
eds & Northrup Co., Philadelphia
hle Testing Machine Div.; American Machine & Metals, Inc., East Moline, Ill.
orge Scherr Co., New York, N. Y.
e Control Co., Chicago
S. Starrett Co., Athol, Mass.
J. Tagliabue Mfg. Co., Brooklyn, N. Y.
te-Jones & Co., Inc., Leetsdale, Pa.
sting Machines, Inc., New York
estinghouse Elec. & Mfg. Co., E. Pgh.
helco Instrument Co., Chicago, Ill.
rl Zeiss, Inc., New York, N. Y.

AMOND WHEELS [147]

rborundum Co., Niagara Falls, N. Y.
rton Co., Worcester, Mass.

E BLOCKS [148]

thorn Steel Co., Boston, Mass.
mer. Shear Knife Co., Homestead, Pa.
rpenter Steel Co., Reading, Pa.
icago Steel Foundry Co., Chicago, Ill.
lumbia Tool Steel Co., Chicago Hts., Ill.
awford & Doherty Foundry Co., Portland, Ore.
. Finkl & Sons Co., Chicago, Ill.
rth-Sterling Steel Co., McKeesport, Pa.
ppenstall Co., Pittsburgh, Pa.
opp Forge Co., Chicago
thuh Steel Co., New York
tional Forge & Ordnance Co., Irvine, Warren County, Pa.

E CASTING MACHINES [149]

olin Corp., Irvington, N. J.
lipse Fuel Engr. Co., Rockford, Ill.
arvill Corporation, Los Angeles, Calif.
ydraulic Press Mfg. Co., Mt. Gilead, O.
ux Machine Co., Chicago
ester Engineering Co., Cleveland, Ohio

E CASTINGS—See Castings, Die

E MACHINERY [150]

llings & Spencer Co., Hartford, Conn.
rboloy Co., Inc., Detroit, Mich.
ntinental Machines, Inc., Minneapolis
rth-Sterling Steel Co., McKeesport, Pa.
rob Bros., Grafton, Wis.

ES [151]

goma Products, Detroit
mer. Shear Knife Co., Homestead, Pa.
W. Bliss Co., Brooklyn, N. Y.
ntinental Machines, Inc., Minneapolis
rth-Sterling Steel Co., McKeesport, Pa.
ppenstall Co., Pittsburgh, Pa.
ester Engrg. Co., Cleveland
ueller Brass Co., Port Huron, Mich.
essed Steel Co., Wilkes-Barre, Pa.
rvice Machine Co., Elizabeth, N. J.
scoloy-Ramet Corp., N. Chicago, Ill.
ales-Strippit Corp., N. Tonawanda, N. Y.
rought Wash. Mfg. Co., Milwaukee, Wis.

E CASTINGS—See Castings, Die

E STEELS [152]

llegheny Ludlum Steel Corp., Brackenridge, Pa.
ndrews Steel Co., Newport, Ky.
thlehem Steel Co., Bethlehem, Pa.
rpenter Steel Co., Reading, Pa.
Crucible Steel Co. of America, New York
Firth-Sterling Steel Co., McKeesport, Pa.
Jessop Steel Co., Washington, Pa.
Kloster Steel Corp., Chicago
Latrobe Electric Steel Co., Latrobe, Pa.
Midvale Co., Philadelphia
Peninsular Steel Co., Cleveland
Swedish-Amer. Steel Corp., Brooklyn, N. Y.
Timken Roller Bearing Co., Canton, O.
Univ.-Cyclops Steel Corp., Bridgeville, Pa.

DIES—Cemented Carbides [153]

Carboloy Co., Detroit, Mich.
Firth-Sterling Steel Co., McKeesport, Pa.
Kennametal, Inc., Latrobe, Pa.
Metal Carbides Corp., Youngstown, Ohio
Moslo Mach. Co., Cleveland, Ohio
Tungsten Elec. Corp., Union City, N. J.
Vascoloy-Ramet Corp., N. Chicago, Ill.

DIES—Sheet Metal Forming [154]

Ajax Steel & Forge Co., Detroit, Mich.
Algoma Products, Detroit
Carboloy Co., Detroit, Mich.
Chicago Steel Foundry Co., Chicago, Ill.
Continental Machines, Inc., Minneapolis
Firth-Sterling Steel Co., McKeesport, Pa.
Modern Engineering Co., St. Louis, Mo.
National Lead Co., New York
Pressed Steel Co., Wilkes-Barre, Pa.
Service Machine Co., Elizabeth, N. J.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Wrought Washer Mfg. Co., Milwaukee

DILATOMETERS [155]

Bristol Co., Waterbury, Conn.
R. Y. Ferner Co., Boston, Mass.

DIPPING BASKETS—See Baskets

DOLOMITE—Refractories [156]

Basic Refractories, Inc., Cleveland

DRAW BENCHES [157]

Aetna-Standard Engr. Co., Youngstown, O.
Ajax Mfg. Co., Cleveland, Ohio
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia
Hydropress, Inc., New York City
Standard Machinery Co., Providence, R. I.
Tube Reducing Corp., Wallington, N. J.
Vaughn Machy. Co., Cuyahoga Falls, O.

DRESSERS—Grinding Wheel [158]

Carboloy Co., Detroit
Carborundum Co., Niagara Falls, N. Y.
Ideal Commutator Dresser Co., Sycamore, Ill.
K. O. Lee & Son Co., Aberdeen, S. D.
Metal Carbides Corp., Youngstown, Ohio
Norton Co., Worcester, Mass.
Willey's Carbide Tool Co., Detroit

DRILL ROD [159]

Allegheny Ludlum Steel Corp., Brackenridge, Pa.
American Brass Co., Waterbury, Conn.
Beals-McCarthy & Rogers, Inc., Buffalo
Benedict-Miller, Inc., Newark, N. J.
H. Boker & Co., Inc., New York
Brown-Wales Co., Boston, Mass.
Carpenter Steel Co., Reading, Pa.
Darwin & Milner, Cleveland
Faitoute Iron & Steel Co., Newark, N. J.
Firth-Sterling Steel Co., McKeesport, Pa.
Peter A. Frasse & Co., Inc., New York
Jessop Steel Co., Washington, Pa.
Kloster Steel Corp., Chicago
Latrobe Electric Steel Co., Latrobe, Pa.
Lehigh Steel Co., New York
Peninsular Steel Co., Cleveland
Pitt. Tool Steel Wire Co., Monaca, Pa.
A. R. Purdy Co., New York
Jos. T. Ryerson & Son, Inc., Chicago
Sandvik Steel, New York
Swedish-American Steel Co., Brooklyn
U. S. Steel Supply Co., Chicago
Edgar T. Ward's Sons Co., Pittsburgh, Pa.

DRILLS—Electric [160]

Beals-McCarthy & Rogers, Inc., Buffalo
Black & Decker Mfg. Co., Towson, Md.
Brown-Wales Co., Boston, Mass.
Cincinnati Elec. Tool Co., Cincinnati, Ohio
Independent Pneumatic Tool Co., Chicago
Ingersoll-Rand Co., Phillipsburg, N. J.
Millers Falls Co., Greenfield, Mass.
Paramount Products Co., New York, N. Y.
Rotor Tool Co., Cleveland
Joseph T. Ryerson & Son, Inc., Chicago
Skilsaw, Inc., Chicago
Stanley Electric Tool Div., The Stanley Works, New Britain, Conn.

DROP FORGINGS—Aluminum [161]

Aluminum Co. of America, Pittsburgh, Pa.
C. O. Bartlett & Snow Co., Cleveland
Transue & Williams Steel Forging Corp., Alliance, Ohio
Wyman-Gordon Co., Worcester, Mass.

DROP FORGINGS—Copper Alloy [162]

American Brass Co., Waterbury, Conn.
Ampco Metal, Inc., Milwaukee, Wis.
Capewell Mfg. Co., Hartford, Conn.
Champion Mach. & Forg. Co., Cleveland
Chase Brass & Cop. Co., Waterbury, Conn.
E. D. Clapp Mfg. Co., Auburn, N. Y.
End. Forg. & Mfg. Co., Inc., Endicott, N. Y.
P. R. Mallory & Co., Indianapolis, Ind.
Mueller Brass Co., Port Huron, Mich.
Revere Copper & Brass, Inc., New York
Rhode Island Tool Co., Providence, R. I.
Steel Improvement & Forge Co., Cleveland

DROP FORGINGS—Steel [163]

Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Amer. Chain Div., A. C. & C., York, Pa.
Billings & Spencer Co., Hartford, Conn.
Bethlehem Steel Co., Bethlehem, Pa.
Bonney Forge & Tool Wks., Allentown, Pa.
Brewer-Titchener Corp., Cortland, N. Y.
Capewell Mfg. Co., Hartford, Conn.
Champion Mach. & Forg. Co., Cleveland
E. D. Clapp Mfg. Co., Auburn, N. Y.
Cleveland Hdwe. & Forging Co., Cleveland
Dom. Forge & Stamping Co., Walkerville, Ont.
End. Forg. & Mfg. Co., Inc., Endicott, N. Y.
Kropp Forge Co., Chicago
Ladish Drop Forge Co., Cudahy, Wis.
Mueller Brass Co., Port Huron, Mich.
Pitts. Forgings Co., Coraopolis, Pa.
Porter Forge & Furnace, Everett, Mass.
Rhode Island Tool Co., Providence, R. I.
Steel Improvement & Forge Co., Cleveland
Transue & Williams Steel Forging Corp., Alliance, Ohio
Wyman-Gordon Co., Worcester, Mass.

DRYING MACHINES [164]

Alvey-Ferguson Co., Cincinnati
Amer. Fdry. Equip. Co., Mishawaka, Ind.
G. S. Blakeslee & Co., Chicago, Ill.
Carl-Mayer Corp., Cleveland
Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.
Continental Ind. Engrs., Inc., Chicago
Dreisbach Engr. Corp., Yonkers, N. Y.
Heilman Boiler Works, Allentown, Pa.
Industrial Oven Engrg. Co., Cleveland
MacDermid, Inc., Waterbury, Conn.
Mahr Mfg. Co., Minneapolis
Metalwash Machinery Co., Irvington, N. J.
Morrison Engineering Co., Cleveland
Niagara Blower Co., New York
Parsons Engr. Corp., Cleveland, Ohio
Pittsburgh Lectrodryer Corp., Pgh., Pa.
Proctor & Schwartz, Philadelphia
N. Ransohoff, Inc., Cincinnati, Ohio
J. O. Ross Engrg. Corp., New York
Salem Engineering Co., Salem, Ohio
F. J. Stokes Machine Co., Philadelphia, Pa.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Tolhurst Centrifugal Div., Amer. Mach. & Met., E. Moline, Ill.
U. S. Galvanizing & Plating Equipment Corp., Brooklyn, N. Y.
Vulcan Corp., Philadelphia, Pa.

DUST CONTROL SYSTEMS [165]

American Blower Corp., Detroit
Amer. Fdry Equip. Co., Mishawaka, Ind.
Cincinnati Elec. Tool Co., Cincinnati, O.
Hild Floor Machine Co., Chicago
Kent Co., Inc., Rome, N. Y.
Kirk and Blum Mfg. Co., Cincinnati, Ohio
Leiman Bros., Newark, N. J.
Pangborn Corp., Hagerstown, Md.
Parsons Engr. Corp., Cleveland, Ohio
Ruemelin Mfg. Co., Milwaukee, Wis.
Claude B. Schneible Co., Chicago
W. W. Sly Mfg. Co., Cleveland, Ohio
B. F. Sturtevant Co., Boston, Mass.
Torit Mfg. Co., St. Paul
Whiting Corp., Harvey, Ill.

DYNAMOMETERS—Traction [165A]

W. C. Dillon & Co., Inc., Chicago

ELECTRIC HEATING ELEMENTS [166]

Alloy Casting Co., Champaign, Ill.
Amer. Elec. Furnace Co., Boston
Amer. Electro Metal Corp., Yonkers, N. Y.
Amer. Fdry Equip. Co., Mishawaka, Ind.
Bellis Heat Treating Co., Branford, Conn.
Brown Fintube Co., Elyria, Ohio
Carborundum Co., Niagara Falls, N. Y.
Cutler-Hammer, Inc., Milwaukee

Despatch Oven Co., Minneapolis
Harry W. Dietert Co., Detroit
Driver-Harris Co., Harrison, N. J.
Wilbur B. Driver Co., Newark, N. J.
Electric Furnace Co., Salem, Ohio
Electro Alloys Co., Elyria, Ohio
General Alloys Co., Boston, Mass.
General Electric Co., Schenectady, N. Y.
Globar Div., Carb. Co., Niagara Falls
Claud S. Gordon Co., Chicago, Ill.
Hevi Duty Electric Co., Milwaukee, Wis.
Hoskins Mfg. Co., Detroit
Lindberg Engineering Co., Chicago
Harold E. Trent Co., Philadelphia, Pa.
Vulcan Corp., Philadelphia, Pa.
Westinghouse Electric & Mfg. Co., E. Pgh.
Edwin L. Wiegand Co., Pittsburgh, Pa.

ELEC. RESISTANCE HEATING [167]
American Car & Foundry Co., New York
Amer. Elec. Furnace Co., Boston
Bellis Heat Treating Co., Branford, Conn.
Commonwealth Elec. & Mfg. Co., Boston
Continental Industrial Engineers, Chicago
Delloy Metals, Philadelphia, Pa.
Wilbur B. Driver Co., Newark, N. J.
Electric Furnace Co., Salem, Ohio
Electro-Alloys Co., Elyria, O.
General Electric Co., Schenectady, N. Y.
Globar Div., Carb. Co., Niagara Falls
Hoskins Mfg. Co., Detroit, Mich.
Lithium Co., Newark, N. J.
National Carbon Co., Inc., New York
Harold E. Trent Co., Philadelphia, Pa.
Vulcan Corp., Philadelphia, Pa.
Westinghouse Electric & Mfg. Co., E. Pgh.
Edwin L. Wiegand Co., Pittsburgh, Pa.

ELECTRIC WELDING—See Welding

ELECTRICAL ALLOYS [168]
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Aluminum Co. of America, Pittsburgh, Pa.
Callite Tungsten Corp., Union City, N. J.
Carpenter Steel Co., Reading, Pa.
Chicago Steel Foundry Co., Chicago, Ill.
Delloy Metals, Philadelphia, Pa.
Driver-Harris Co., Harrison, N. J.
Wilbur B. Driver Co., Newark, N. J.
Hoskins Mfg. Co., Detroit, Mich.
Jessop Steel Co., Washington, Pa.
P. R. Mallory & Co., Indianapolis, Ind.
Powder Metallurgy, Inc., Long Island City, N. Y.
Jos. T. Ryerson & Son, Inc., Chicago
Taylor-Winfield Corp., Warren, Ohio
Welding Sales & Engrg. Co., Detroit

ELECTRICAL RESISTORS [169]
Alloy Casting Co., Champaign, Ill.
Carborundum Co., Niagara Falls, N. Y.
Chicago Steel Foundry Co., Chicago, Ill.
Clark Controllers Co., Cleveland, Ohio
Continental Industrial Engineers, Chicago
Cutler-Hammer, Inc., Milwaukee
Driver-Harris Co., Harrison, N. J.
Elec. Controller & Mfg. Co., Cleveland
General Alloys Co., Boston, Mass.
General Electric Co., Schenectady, N. Y.
Globar Div., Carb. Co., Niagara Falls
Hoskins Mfg. Co., Detroit, Mich.
Laganke Electric Co., Cleveland
P. R. Mallory & Co., Indianapolis, Ind.
National Carbon Co., Inc., New York
Standard Alloy Co., Cleveland
Harold E. Trent Co., Philadelphia, Pa.
Westinghouse Electric & Mfg. Co., E. Pgh.
Edwin L. Wiegand Co., Pittsburgh, Pa.

ELECTRODE HOLDERS—Welding [170]
Air Reduction, New York
Allied Weld-craft, Inc., Indianapolis, Ind.
Arcos Corp., Philadelphia, Pa.
Brown-Wales Co., Boston, Mass.
Dockson Corp., Detroit
Eisler Engineering Co., Newark, N. J.
Ergolyte Mfg. Co., Philadelphia
General Electric Co., Schenectady, N. Y.
Harnischfeger Corp., Milwaukee, Wis.
Hobart Brothers Co., Troy, Ohio
Jackson Products, Detroit
K. O. Lee & Son Co., Aberdeen, S. D.
Lincoln Electric Co., Cleveland, Ohio
P. R. Mallory & Co., Indianapolis, Ind.
Marquette Mfg. Co., Inc., Minneapolis
National Cylinder Gas Co., Chicago
Horace T. Potts Co., Philadelphia, Pa.
Smith Welding Equip. Co., Minneapolis
Stoody Co., Whittier, Cal.
U. S. Steel Supply Co., Chicago
Universal Power Corp., Cleveland
Welding Engineering Co., Milwaukee, Wis.
Westinghouse Electric & Mfg. Co., E. Pgh.

ELECTRODES—Electric Furnace [171]
Bellis Heat Treating Co., Branford, Conn.
General Electric Co., Schenectady, N. Y.
A. F. Holden Co., New Haven, Conn.
International Graphite & Electrode Corp. St. Marys, Pa.
National Carbon Co., Inc., Cleveland
National Carbon Co., Inc., Electrode Sales Div., New York
Upton Elect. Salt Bath Fur. Co., Detroit
Vulcan Corp., Philadelphia, Pa.
Westinghouse Electric & Mfg. Co., E. Pgh.

ELECTRODES—Hard Surfacing [172]
Air Reduction, New York
American Agile Corp., Cleveland
American Chain & Cable Co., Bridgeport, Conn.
Amer. Mang. Steel Div., Amer. Brake Shoe Co., Chicago Heights, Ill.
Callite Tungsten Corp., Union City, N. J.
Coast Metals, Inc., Canton, O.
General Electric Co., Schenectady, N. Y.
Harnischfeger Corp., Milwaukee
Lincoln Electric Co., Cleveland
Marquette Mfg. Co., Minneapolis
McCauley Alloy Co., Chicago Heights, Ill.
National Cylinder Gas Co., Chicago
Page Steel & Wire, Monessen, Pa.
Jos. T. Ryerson & Son, Inc., Chicago
Stoody Co., Whittier, Calif.
Taylor-Wharton Iron & Steel Co., Easton, Pennsylvania and High Bridge, N. J.
Universal Power Corp., Cleveland
Wall-Colmonoy Corp., Detroit
Welding Sales & Engrg. Co., Detroit
Westinghouse Elec. & Mfg. Co., E. Pgh., Pa.

ELECTRODES—Resistance Welding [173]
Air Reduction, New York
American Brass Co., Waterbury, Conn.
Amer. Steel & Wire Co., Cleveland, Ohio
Ampco Metal, Inc., Milwaukee, Wis.
Eisler Engineering Co., Newark, N. J.
Electroloy Co., Inc., Bridgeport, Conn.
Federal Machine & Welder Co., Warren, O.
General Electric Co., Schenectady, N. Y.
Harnischfeger Corp., Milwaukee
W. J. Holliday & Co., Hammond, Ind.
P. R. Mallory & Co., Indianapolis, Ind.
National Cylinder Gas Co., Chicago
Jos. T. Ryerson & Son, Inc., Chicago
S-M-S Corp., Detroit
U. S. Steel Supply Co., Chicago
Universal Power Corp., Cleveland
Welding Machines Mfg. Co., Detroit
Welding Sales & Engrg. Co., Detroit

ELECTRODES—Stainless [174]
Air Reduction, New York
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Alloy Casting Co., Champaign, Ill.
American Steel & Wire, Cleveland, Ohio
Arcos Corp., Philadelphia, Pa.
H. Boker & Co., Inc., New York
Brown-Wales Co., Boston, Mass.
Wilbur B. Driver Co., Newark, N. J.
Eutectic Welding Alloys, Inc., New York
General Alloys Co., Boston, Mass.
General Electric Co., Schenectady, N. Y.
Harnischfeger Corp., Milwaukee, Wis.
W. J. Holliday & Co., Hammond, Ind.
Krembs & Co., Chicago
K. O. Lee & Son Co., Aberdeen, S. D.
Lincoln Electric Co., Cleveland, Ohio
Marquette Mfg. Co., Inc., Minneapolis
Maurath, Inc., Cleveland, Ohio
McKay Co., Pittsburgh, Pa.
Metal & Thermit Corp., New York
National Cylinder Gas Co., Chicago
Ohio Steel Foundry Co., Springfield, Ohio
Page Steel & Wire Div., American Chain & Cable Co., Monessen, Pa.
Jos. T. Ryerson & Son, Inc., Chicago
A. O. Smith Corp., Milwaukee, Wis.
U. S. Steel Supply Co., Chicago
Universal Power Corp., Cleveland
Westinghouse Electric & Mfg. Co., E. Pgh.

ELECTRODES—Welding, Carbon [175]
Air Reduction, New York
Amer. Steel & Wire Co., Cleveland, Ohio
Brown-Wales Co., Boston, Mass.
General Electric Co., Schenectady, N. Y.
W. J. Holliday & Co., Hammond, Ind.
Int. Graph. & Elect. Corp., St. Marys, Pa.
International Nickel Co., New York, N. Y.
Lincoln Electric Co., Cleveland, Ohio
Marquette Mfg. Co., Inc., Minneapolis
McKay Co., York, Pa.
National Carbon Co., Inc., New York
National Cylinder Gas Co., Chicago
Ohio Steel Foundry Co., Springfield, O
Page Steel & Wire Div., American C & Cable Co., Monessen, Pa.
Horace T. Potts Co., Philadelphia, P
Speer Carbon Co., St. Marys, Pa.
Stoody Co., Whittier, Calif.
U. S. Graphite Co., Saginaw, Mich.
U. S. Steel Supply Co., Chicago
Universal Power Corp., Cleveland
Westinghouse Electric & Mfg. Co., E. P

ELECTRODES—Welding, Coated [176]
Air Reduction, New York
Alloy Casting Co., Champaign, Ill.
American Agile Corp., Cleveland
Amer. Mang. Steel Div., American Br Shoe Co., Chicago Hts.
American Steel & Wire, Cleveland, O
Arcos Corp., Philadelphia, Pa.
H. Boker & Co., Inc., New York
Brown-Wales Co., Boston, Mass.
Callite Tungsten Corp., Union City, N
Coast Metals, Inc., Canton, O.
Electric Arc, Inc., Newark, N. J.
General Electric Co., Schenectady, N.
Harnischfeger Corp., Milwaukee, Wis.
W. J. Holliday & Co., Hammond, In
Hoskins Mfg. Co., Detroit
International Nickel Co., New York, N
Krembs & Co., Chicago
K. O. Lee & Son Co., Aberdeen, S. D.
Lincoln Electric Co., Cleveland, Ohio
Manganese Steel Forge Co., Philadelp
Marquette Mfg. Co., Inc., Minneapolis
Maurath, Inc., Cleveland, Ohio
McKay Co., Pittsburgh, Pa.
Metal & Thermit Corp., New York
Moslo Mach. Co., Cleveland, Ohio
National Cylinder Gas Co., Chicago
Ohio Steel Foundry Co., Springfield, O
Page Steel & Wire Div., American Ch & Cable Co., Monessen, Pa.
Horace T. Potts Co., Philadelphia, Pa.
Jos. T. Ryerson & Son, Inc., Chicago
A. O. Smith Corp., Milwaukee, Wis.
U. S. Steel Supply Co., Chicago
Universal Power Corp., Cleveland
Welding Sales & Engrg. Co., Detroit
Westinghouse Electric & Mfg. Co., E. P
Whitehead Metal Products Co., New Y
Wilson Welder & Metals Co., Inc.,

ELECTROLYTIC IRON [177]
Ekstrand & Tholand, Inc., New York
Plastic Metals, Inc., Johnstown, Pa.

ELECTROPLATING EQUIPMENT SUPPLIES [178]
American Inst. Co., Silver Spring, Md.
Columbia Electric Mfg. Co., Cleveland
Crown Rheostat & Supply Co., Chicag
Duriron Co., Inc., Dayton, O.
Hanson-Van Winkle-Munning Co., Ma wan, N. J.
Heil Engineering Co., Cleveland, Ohio
Hobart Brothers Co., Troy, Ohio
MacDermid, Inc., Waterbury, Conn.
Meaker Co., Chicago
Puritan Mfg. Co., Waterbury, Conn.
Rapid Electroplating Process, Chicago
Sparkler Mfg. Co., Mundelein, Ill.
Frederic B. Stevens, Inc., Detroit
Thwing-Albert Instrument Co., Phila.,
Udylite Corp., Detroit
United Chromium, Inc., New York
U. S. Galvanizing & Plating Equipme Corp., Brooklyn, N. Y.
Westinghouse Electric & Mfg. Co., E. P
Wilkens-Anderson Co., Chicago

ELECTROPLATING PROCESSES MATERIALS [179]
Alrose Chemical Co., Providence, R. I.
Colonial Alloys Co., Philadelphia
Crown Rheostat & Supply Co., Chicago
Gilbert Cummins & Co., Baltimore, M
E. I. du Pont de Nemours & Co., I Wilmington, Del.
Indium Corp. of America, New York
MacDermid, Inc., Waterbury, Conn.
Oakite Products, Inc., New York
Rapid Electroplating Process, Chicago
Solventol Chemical Products, Inc., Detr
Sturgis Products Company, Sturgis, Mi
Technical Process Div., Colonial Alloys C Philadelphia, Pa.
Udylite Corp., Detroit
United Chromium, Inc., New York

EMERY WHEELS—See Grinding Whe

EXHAUST SYSTEMS [180]
American Blower Corp., Detroit
Amer. F'dry Equip. Co., Mishawaka, In

ks Mfg. Co., Chicago, Ill.
Bothezat Vent. Equip. Div., Amer. Mach.
Metals, Inc., E. Moline, Ill.
spatch Oven Co., Minneapolis, Minn.
Vilbiss Co., Toledo
enrich Corp., L. I. City, N. Y.
d S. Gordon Co., Chicago, Ill.
lman Boiler Works, Allentown, Pa.
ustrial Oven Engrg. Co., Cleveland
Leach Machinery Co., Providence, R. I.
eDermid, Inc., Waterbury, Conn.
cleod Co., Cincinnati, Ohio
e Safety Appliances Co., Pittsburgh
coomb-Detroit Co., Detroit
sche Airbrush Co., Chicago
arborn Corp., Hagerstown, Md.
rsons Engr. Corp., Cleveland, Ohio
ude B. Schneible Co., Detroit
F. Sturtevant Co., Boston, Mass.
te-Jones & Co., Inc., Leetsdale, Pa.
rt Mfg. Co., St. Paul, Minn.

XTRUDED SHAPES [181]
minum Co. of America, Pittsburgh, Pa.
erican Brass Co., Waterbury, Conn.
er. Magnesium Corp., Pittsburgh, Pa.
n Aluminum & Brass Corp., Detroit
ase Brass & Cop. Co., Waterbury, Conn.
w Chemical Co., Midland, Mich.
R. & J. Rathbone, Palmer, Mass.
ere Copper & Brass, Inc., New York
ynolds Metals Co., Louisville, Ky.
hitehead Metal Products Co., New York

NS—High Temp. Recirculating [182]
oy Casting Co., Champaign, Ill.
erican Blower Corp., Detroit
er. Mach. & Met., Inc., E. Moline, Ill.
erican Manganese Steel Div., Chicago
ts, Ill.
icago Steel Foundry Co., Chicago, Ill.
spatch Oven Co., Minneapolis, Minn.
rden City Fan Co., Chicago
neral Alloys Co., Boston, Mass.
lman Boiler Works, Allentown, Pa.
ustrial Gas Engineering Co., Chicago
air Mfg. Co., Minneapolis
hiana Prod. Corp., Michigan City, Ind.
rrison Engineering Co., Inc., Cleveland
o Steel Foundry Co., Springfield, Ohio
erling-Alloys, Inc., Woburn, Mass.
F. Sturtevant Co., Boston, Mass.
te-Jones & Co., Inc., Leetsdale, Pa.
rold E. Trent Co., Philadelphia, Pa.
ulcan Corp., Philadelphia, Pa.

NS—Ventilating [183]
erican Blower Corp., Detroit
no Engineering Co., Meriden, Conn.
Bothezat Vent. Equip. Div., American
Machine & Metals, Inc., E. Moline, Ill.
spatch Oven Co., Minneapolis, Minn.
eVilbiss Co., Toledo
arion Co., Inc., Dayton, O.
erson Electric Mfg. Co., St. Louis
frey Mfg. Co., Columbus, Ohio
agara Blower Co., New York
sche Airbrush Co., Chicago
ude B. Schneible Co., Detroit
F. Sturtevant Co., Boston, Mass.
te-Jones & Co., Inc., Leetsdale, Pa.
rrington Mfg. Co., Torrington, Conn.

RROALLOYS [184]
rnegie-Illinois Steel Corp., Pgh., Pa.
romium Mining & Smelting Corp., Montreal
lmax Molybdenum Co., New York
pper Alloy Fdry. Co., Hillside, N. J.
strand & Tholand, Inc., New York
ectro Metallurgical Co., New York
ote Mineral Co., Philadelphia, Pa.
arles Hardy, Inc., New York
ckson Iron & Steel Co., Jackson, O.
tal & Thermit Corp., New York
ller & Co., Chicago
olybdenum Corp. of America, Pittsburgh
tralloy Corp., New York
o Ferro Alloys Corp., Canton, Ohio
tsburgh Met. Co., Niagara Falls, N. Y.
wder Metals & Alloys, Inc., New York
o Ferro Alloys Co., Chattanooga, Tenn.
mmerill Tubing Co., Bridgeport, Pa.
anium Alloy Mfg. Co., Niagara Falls
nadium Corp. of America, New York

RROMOLYBDENUM [185]
lmax Molybdenum Co., New York
ote Mineral Co., Philadelphia, Pa.
olybdenum Co. of America, Pgh., Pa.

LTER CLOTH [186]
lop Engineering Corp., Milldale, Conn.
dubon Wire Cloth Corp., Phila., Pa.
Buffalo Wire Works Co., Buffalo
Chase Brass & Cop. Co., Waterbury, Conn.
Ludlow-Saylor Wire Co., St. Louis
Newark Wire Cloth Co., Newark, N. J.
Owens-Corning Fiberglas Co., Toledo, Ohio
T. Shriver & Co., Inc., Harrison, N. J.
W. S. Tyler Co., Cleveland
Whitehead Metal Products Co., New York
Wickwire Spencer Steel Co., New York

FILTERS—Air [187]
Alsop Engineering Corp., Milldale, Conn.
Amer. Fdry. Equip. Co., Mishawaka, Ind.
Binks Mfg. Co., Chicago, Ill.
Carborundum Co., Niagara Falls, N. Y.
Cuno Engineering Co., Meriden, Conn.
DeVilbiss Co., Toledo
Hauck Mfg. Co., Brooklyn, N. Y.
Owens-Corning Fiberglas Corp., Toledo
Tate-Jones & Co., Inc., Leetsdale, Pa.
Westinghouse Electric & Mfg. Co., E. Pgh.

FILTERS—Oil [188]
Alsop Engineering Corp., Milldale, Conn.
S. F. Bowser & Co., Ft. Wayne, Ind.
Carborundum Co., Niagara Falls, N. Y.
Cuno Engineering Co., Meriden, Conn.
Fostoria Pressed Steel Co., Fostoria, O.
Maxon Premix Burner Co., Muncie, Ind.
Michiana Prod. Corp., Michigan City, Ind.
Moraine Products Div., Dayton, O.
North American Mfg. Co., Cleveland
T. Shriver & Co., Inc., Harrison, N. J.
Sparkler Mfg. Co., Mundelein, Ill.
Tate-Jones & Co., Inc., Leetsdale, Pa.
U. S. Hoffman Machinery Co., New York

FIRE BRICK [189]
Acme Brick Co., Ft. Worth, Texas
Armstrong Cork Co., Lancaster, Pa.
Babcock & Wilcox Co., New York
Carborundum Co., Perth Amboy, N. J.
Chicago Retort & Fire Brick Co., Chicago
Electro Refract. & Alloys Corp., Buffalo
Federal Refractories Corp., Akron, O.
General Refractories Co., Philadelphia
A. P. Green Fire Brick Co., Mexico, Mo.
Illinois Clay Products Co., Joliet, Ill.
Johns-Manville, New York
Laclede-Christy Clay Prod. Co., St. Louis
McLeod & Henry Co., Troy, N. Y.
Norton Co., Worcester, Mass.
Plibrico Jointless Firebrick Co., Chicago
Quigley Co., Inc., New York
Ramtite Co., Chicago
Tate-Jones & Co., Inc., Leetsdale, Pa.
Chas. Taylor Sons Co., Cincinnati, O.

FIRE BRICK—Insulating [190]
Armstrong Cork Co., Lancaster, Pa.
Babcock & Wilcox Co., New York
Carborundum Co., Perth Amboy, N. J.
Eagle-Picher Sales Co., Cincinnati
Federal Refractories Corp., Akron, O.
A. P. Green Fire Brick Co., Mexico, Mo.
Harbison-Walker Refrac. Co., Pittsburgh
Illinois Clay Products Co., Joliet, Ill.
Ironton Fire Brick Co., Ironton, O.
Johns-Manville, New York
M. W. Kellogg Co., Jersey City, N. J.
Laclede-Christy Clay Prod. Co., St. Louis
National Carbon Co., Inc., Cleveland
North American Refrac. Co., Cleveland
Plibrico Jointless Firebrick Co., Chicago
Quigley Co., Inc., New York
Ramtite Co., Chicago
Refractory & Insulation Corp., New York
Tate-Jones & Co., Inc., Leetsdale, Pa.
Chas. Taylor Sons Co., Cincinnati, O.

FLAME HARDENING EQUIPMENT [191]
Air Reduction, New York
Am. Gas Furnace Co., Elizabeth, N. J.
Lakeside Steel Improv. Co., Cleveland
Morrison Engineering Co., Cleveland
National Machine Works, Chicago
W. S. Rockwell Co., New York
Selas Co., Philadelphia
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia

FLATS—Cold Drawn [192]
Beals-McCarthy & Rogers, Inc., Buffalo
Bliss & Laughlin, Inc., Harvey, Ill.
Driver-Harris Co., Harrison, N. J.
Firth-Sterling Steel Co., McKeesport, Pa.
Peter A. Frasse & Co., New York
Joslyn Mfg. & Supply Co., Ft. Wayne, Ind.
La Salle Steel Co., Hammond, Ind.
Latrobe Electric Steel Co., Latrobe, Pa.
International Nickel Co., Inc., N. Y. City
Horace T. Potts Co., Philadelphia, Pa.
Republic Steel Corp., Cleveland, Ohio
Jos. T. Ryerson & Son, Inc., Chicago
U. S. Steel Supply Co., Chicago
Edgar T. Ward's Sons Co., Pittsburgh, Pa.
Whitehead Metal Products Co., New York

FLUX—Brazing [193]
Air Reduction, New York
Aluminum Co. of America, Pittsburgh, Pa.
Amer. Solder & Flux Co., Philadelphia
Automatic Gasflux Mfg. Co., Mansfield, O.
Beals-McCarthy & Rogers, Inc., Buffalo
Chicago Hdw. Fdry Co., N. Chicago
Eutectic Welding Alloys, Inc., New York
Fidelity Chemical Prod. Corp., Newark
Firth-Sterling Steel Co., McKeesport, Pa.
Gasflux Co., Mansfield, Ohio
General Welding & Equip. Co., Boston
Handy & Harman, New York
International Nickel Co., Inc., N. Y. City
Krembs & Co., Chicago
Linde Air Products Co., New York, N. Y.
P. R. Mallory & Co., Inc., Indianapolis
National Cylinder Gas Co., Chicago
Horace T. Potts Co., Philadelphia, Pa.
Special Chemicals Corp., New York
Superior Flux Co., Cleveland
Torit Mfg. Co., St. Paul, Minn.
U. S. Steel Supply Co., Chicago
Universal Power Corp., Cleveland
Whitehead Metal Products Co., New York

FLUX—Foundry [194]
Apex Smelting Co., Chicago
Foundry Services, Inc., New York
Niagara Falls Smelting & Refining Corp., Buffalo, N. Y.

FLUX—Silver Solder [195]
Air Reduction, New York
Alrose Chemical Co., Providence, R. I.
Amer. Solder & Flux Co., Philadelphia
E. C. Atkins & Co., Indianapolis, Ind.
Automatic Gasflux Mfg. Co., Mansfield, O.
Chicago Hdw. Fdry. Co., N. Chicago
Fidelity Chemical Prod. Corp., Newark
Gasflux Co., Mansfield, Ohio
Handy & Harman, New York
Krembs & Co., Chicago
P. R. Mallory & Co., Indianapolis, Ind.
National Cylinder Gas Co., Chicago
Horace T. Potts Co., Philadelphia, Pa.
Special Chemicals Corp., New York
Superior Flux Co., Cleveland
Universal Power Corp., Cleveland
Westinghouse Elec. & Mfg. Co., E. Pgh.
Whitehead Metal Products Co., New York

FLUX—Welding [196]
Air Reduction, New York
Aluminum Co. of America, Pittsburgh, Pa.
Amer. Solder & Flux Co., Philadelphia
Beals-McCarthy & Rogers, Inc., Buffalo
Brown-Wales Co., Boston, Mass.
Chicago Hdw. Fdry. Co., N. Chicago
Eutectic Welding Alloys, Inc., New York
Fidelity Chemical Prod. Corp., Newark
Foote Mineral Co., Philadelphia
General Welding & Equip. Co., Boston
Handy & Harman, New York, N. Y.
International Nickel Co., Inc., N. Y. City
Krembs & Co., Chicago
Linde Air Products Co., New York
National Cylinder Gas Co., Chicago
Horace T. Potts Co., Philadelphia, Pa.
Smith Welding Equip. Co., Minneapolis
Special Chemicals Corp., New York
Superior Flux Co., Cleveland
Tolman Mfg. Co., Boston, Mass.
Torit Mfg. Co., St. Paul, Minn.
U. S. Steel Supply Co., Chicago
Universal Power Corp., Cleveland
Victor Equipment Co., San Francisco
Whitehead Metal Products Co., New York

FORGING MACHINES [197]
Acme Machinery Div., Hill Acme Co., Cleveland, Ohio
Ajax Mfg. Co., Cleveland, Ohio
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia, Pa.
Billings & Spencer Co., Hartford, Conn.
A. Finkl & Sons Co., Chicago
Hydropress, Inc., New York City
Lake Erie Engr. Corp., Buffalo, N. Y.
National Machinery Co., Tiffin, Ohio

FORGING PRESSES—See Presses

FORGING ROLLS [198]
Ajax Mfg. Co., Cleveland, Ohio
A. Finkl & Sons Co., Chicago
Heppenstall Co., Pittsburgh, Pa.
Midvale Co., Philadelphia
SKF Steels, Inc., New York
Sutton Engineering Co., Pittsburgh

FORGINGS [199]
Achorn Steel Co., Boston, Mass.
Ajax Steel & Forge Co., Detroit, Mich.
Aluminum Co., of America, Pittsburgh, Pa.
Amer. Car & F'dry Co., New York
Amer. Locomotive Co., Schenectady, N. Y.
Bethlehem Steel Co., Bethlehem, Pa.
Billings & Spencer Co., Hartford, Conn.
Bonney Forge & Tool Wks., Allentown, Pa.
Capewell Mfg. Co., Hartford, Conn.
Carnegie-Illinois Steel Corp., Pgh., Pa.
Chase Brass & Cop. Co., Waterbury, Conn.
E. D. Clapp Mfg. Co., Auburn, N. Y.
Cleveland Hdwe. & Forging Co., Cleveland
Columbia Steel Co., San Francisco, Calif.
Dominion Forge & Stamping Co., Ltd., Walkerville, Ont., Canada
End. Forge & Mfg. Co., Inc., Endicott, N. Y.
Erie Forge Co., Erie, Pa.
A. Finkl & Sons Co., Chicago, Ill.
Firth-Sterling Steel Co., McKeesport, Pa.
General Metals Corp., Los Angeles
Heller Brothers Co., Newark, N. J.
Heppenstall Co., Pittsburgh, Pa.
W. J. Holliday & Co., Hammond, Ind.
Kloster Steel Corp., Chicago
Kropp Forge Co., Chicago
Ladish Drop Forge Co., Cudahy, Wis.
Chas. E. Larson & Son, Inc., Chicago
Latrobe Electric Steel Co., Latrobe, Pa.
Manganese Steel Forge Co., Philadelphia
Mesta Machine Co., Pittsburgh
Midvale Co., Nicetown, Philadelphia, Pa.
Mueller Brass Co., Port Huron, Mich.
National Forge & Ordnance Co., Irvine, Warren County, Pa.
National Tube Co., Pittsburgh, Pa.
Pitts. Forgings Co., Coraopolis, Pa.
Porter Forge & Furnace, Everett, Mass.
Horace T. Potts Co., Philadelphia, Pa.
Revere Copper & Brass Co., New York
SKF Steels, Inc., New York City
Standard Steel Works Div., Baldwin Locomotive Works, Philadelphia, Pa.
Stearns Rogers Mfg. Co., Denver, Colo.
Steel Improvement & Forge Co., Cleveland
Tenn. Coal, Iron & R. R. Co., Birm., Ala.
Transue & Williams Steel Forging Corp., Alliance, Ohio
Tube Turns, Louisville, Ky.
Wyman-Gordon Co., Worcester, Mass.

FORGINGS—Aluminum [200]
Aluminum Co. of America, Pittsburgh, Pa.
Bohn Alum. & Brass Corp., Detroit
Jos. T. Ryerson & Son, Inc., Chicago
Scovill Mfg. Co., Waterbury, Conn.
Tube Turns, Louisville, Ky.
Wyman-Gordon Co., Worcester, Mass.

FORGINGS—Brass, Bronze or Copper [201]
American Brass Co., Waterbury, Conn.
Amer. Manganese Bronze Co., Phila.
Ampco Metal, Inc., Milwaukee, Wis.
Champion Mach. & Forg. Co., Cleveland
E. D. Clapp Mfg. Co., Auburn, N. Y.
Koppers Co., Bartlett Hayward Div., Baltimore, Md.
P. R. Mallory & Co., Inc., Indianapolis
S-M-S Corp., Detroit
Scovill Mfg. Co., Waterbury, Conn.
Steel Improvement & Forge Co., Cleveland
Titan Metal Mfg. Co., Bellefonte, Pa.
Transue & Williams Steel Forging Corp., Alliance, Ohio

FORGINGS—Composite Steel Die Sections [202]
Ajax Steel & Forge Co., Detroit
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Chicago Steel Foundry Co., Chicago, Ill.
Forging & Casting Corp., Ferndale, Mich.
Kropp Forge Co., Chicago
Chas. E. Larson & Son, Inc., Chicago
Transue & Williams Steel Forging Corp., Alliance, Ohio

FORGINGS—High Speed and Alloy Tool Steels [203]
Achorn Steel Co., Boston, Mass.
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Atlantic Steel Co., New York
H. Boker & Co. Inc., New York
Bonney Forge & Tool Wks., Allentown, Pa.
Capewell Mfg. Co., Hartford, Conn.
Champion Mach. & Forg. Co., Cleveland
E. D. Clapp Mfg. Co., Auburn, N. Y.
Columbia Tool Steel Co., Chicago Hts., Ill.
Darwin & Milner, Cleveland
Firth-Sterling Steel Co., McKeesport, Pa.
Forging & Casting Corp., Ferndale, Mich.
Heppenstall Co., Pittsburgh, Pa.
Kloster Steel Corp., Chicago
Kropp Forge Co., Chicago
Latrobe Electric Steel Co., Latrobe, Pa.
Midvale Co., Nicetown, Philadelphia, Pa.
Horace T. Potts Co., Philadelphia, Pa.
Steel Improvement & Forge Co., Cleveland
Transue & Williams Steel Forging Corp., Alliance, Ohio
Tube Turns, Louisville, Ky.
Uddeholm Co. of America, New York
Univ.-Cyclops Steel Corp., Bridgeville, Pa.

FORGINGS—Magnesium [204]
Aluminum Co. of America, Pittsburgh, Pa.
Amer. Magnesium Corp., Pittsburgh, Pa.
Bohn Alum. & Brass Corp., Detroit
E. D. Clapp Mfg. Co., Auburn, N. Y.
Dow Chemical Co., Midland, Mich.
Revere Copper & Brass Inc., New York
Stearns Rogers Mfg. Co., Denver, Colo.
Steel Improvement & Forge Co., Cleveland
Tube Turns, Louisville, Ky.

FORGINGS—SAE Steels [205]
Ajax Steel & Forge Co., Detroit
Benedict Miller, Inc., Newark, N. J.
Bethlehem Steel Co., Bethlehem, Pa.
Bonney Forge & Tool Wks., Allentown, Pa.
Brewer-Titchener Corp., Cortland, N. Y.
Capewell Mfg. Co., Hartford, Conn.
Champion Mach. & Forg. Co., Cleveland
E. D. Clapp Mfg. Co., Auburn, N. Y.
Dom. Forge & Stamping Co., Walkerville, Ont.
End. Forg. & Mfg. Co., Inc., Endicott, N. Y.
A. Finkl & Sons Co., Chicago, Ill.
Forging & Casting Corp., Ferndale, Mich.
Heppenstall Co., Pittsburgh, Pa.
Kropp Forge Co., Chicago
Ladish Drop Forge Co., Cudahy, Wis.
Midvale Co., Nicetown, Philadelphia, Pa.
National Forge & Ordnance Co., Irvine, Warren County, Pa.
Pitts. Forgings Co., Coraopolis, Pa.
Porter Forge & Furnace, Everett, Mass.
Horace T. Potts Co., Philadelphia, Pa.
SKF Steels, Inc., New York City
Standard Steel Works Div., Baldwin Locomotive Works, Philadelphia, Pa.
Steel Improvement & Forge Co., Cleveland
Transue & Williams Steel Forging Corp., Alliance, Ohio
Tube Turns, Louisville, Ky.
Wheelock, Lovejoy, Cambridge, Mass.
Wyman-Gordon Co., Worcester, Mass.

FORGINGS—Stainless [206]
Ajax Steel & Forge Co., Detroit
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Bonney Forge & Tool Wks., Allentown, Pa.
G. O. Carlson, Inc., Thorndale, Pa.
E. D. Clapp Mfg. Co., Auburn, N. Y.
End. Forg. & Mfg. Co., Inc., Endicott, N. Y.
Firth-Sterling Steel Co., McKeesport, Pa.
Forging & Casting Corp., Ferndale, Mich.
Heppenstall Co., Pittsburgh, Pa.
Kropp Forge Co., Chicago
Ladish Drop Forge Co., Cudahy, Wis.
Latrobe Electric Steel Co., Latrobe, Pa.
Midvale Co., Nicetown, Philadelphia, Pa.
National Forge & Ordnance Co., Irvine, Warren County, Pa.
Pitts. Forgings Co., Coraopolis, Pa.
Horace T. Potts Co., Philadelphia, Pa.
Rustless Iron & Steel Corp., Balt., Md.
Steel Improvement & Forge Co., Cleveland
Transue & Williams Steel Forging Corp., Alliance, Ohio
Univ.-Cyclops Steel Corp., Bridgeville, Pa.

FOUNDRY—Core, Mold Washes [207]
Acheson Colloids Corp., Port Huron, Mich.
Carborundum Co., Perth Amboy, N. J.
Certified Core Oil Co., Cicero, Ill.
Foundry Services, Inc., New York City
National Carbon Co., Inc., New York
Pennsylvania Foundry Supply & Sand Co., Philadelphia, Pa.
Swan-Finch Oil Corp., New York, N. Y.
Titanium Alloy Mfg. Co., Niagara Falls
U. S. Graphite Co., Saginaw, Mich.
Whitehead Bros. Co., New York, N. Y.

FOUNDRY EQUIP. SUPPLIES [208]
Amer. F'dry Equip. Co., Mishawaka, Ind.
C. O. Bartlett & Snow Co., Cleveland
Beardsley & Piper Co., Chicago
Binks Manufacturing Co., Chicago, Ill.
Brickseal Ref. Co., Hoboken, N. J.
Campbell-Hausfeld Co., Harrison, Ohio
Carl-Mayer Corp., Cleveland
Detroit Electric Furnace Div., Kuhlman Electric Co., Bay City, Mich.
Harry W. Dietert Co., Detroit, Mich.
Eclipse Fuel Engr. Co., Rockford, Ill.
Elwell-Parker Electric Co., Cleveland
Foundry Services, Inc., New York
Globe Machine & Stamping Co., Cleve
E. F. Houghton & Co., Philadelphia
Jeffrey Mfg. Co., Columbus, Ohio
Johns-Manville, New York
Lancaster Iron Works, Inc., Lancaster,
Link-Belt Co., Chicago
Mahr Mfg. Co., Minneapolis
Osborn Mfg. Co., Cleveland
Pangborn Corp., Hagerstown, Md.
Parsons Engr. Corp., Cleveland, Ohio
Pennsylvania Foundry Supply & Sand Philadelphia, Pa.
Royer F'dry. & Machine Co., Kingston,
W. W. Sly Mfg. Co., Cleveland
Frederic B. Stevens, Inc., Detroit
Tabor Manufacturing Co., Philadelphi
Whitehead Bros. Co., New York, N. Y.
Whiting Corp., Harvey, Ill.

FURNACE BELTS [209]
Alloy Casting Co., Champaign, Ill.
Audubon Wire Cloth Corp., Philadelphi
Brown Fintube Co., Elyria, Ohio
Calorizing Co., Pittsburgh, Pa.
Chicago Steel Foundry Co., Chicago, Il
Driver-Harris Co., Harrison, N. J.
Electro Alloys Co., Elyria, Ohio
Fahralloy Co., Harvey, Ill.
General Alloys Co., Boston, Mass.
Hoskins Mfg. Co., Detroit
Michigan Steel Casting Co., Detroit
Ohio Steel Foundry Co., Springfield, O
Standard Alloy Co., Cleveland
Sterling-Alloys, Inc., Woburn, Mass.
Surface Combustion, Toledo
Harold E. Trent Co., Philadelphia, Pa.
Vulcan Corp., Philadelphia

FURNACE CONTROLS [210]
Amer. Gas Furnace Co., Elizabeth, N.
Automatic Temp. Control, Inc., Phila.
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia,
Burling Instrument Co., Newark, N. J.
Chicago Flexible Shaft Co., Chicago
Continental Steel Corp., Kokomo, Ind.
Flinn & Dreffein Co., Chicago, Ill.
Foxboro Co., Foxboro, Mass.
General Electric Co., Schenectady, N.
Claud S. Gordon Co., Chicago, Ill
Hays Corp., Michigan City, Ind.
Hevi Duty Elec. Co., Milwaukee, Wis.
Hoskins Mfg. Co., Detroit
Illinois Testing Lab., Inc., Chicago
C. M. Kemp. Mfg. Co., Baltimore, Md.
Leeds & Northrup Co., Philadelphia, P
Lindberg Engineering Co., Chicago
Charles A. Martin Co., Chicago
Maxon Premix Burner Co., Muncie, In
National Machine Works, Chicago
Partlow Corp., New Hartford, N. Y.
R-S Products Corp., Philadelphia, Pa.
Arklay S. Richards Co., Inc., Newton H lands, Mass.
W. S. Rockwell Co., New York
Surface Combustion, Toledo
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia, Pa.
Westinghouse Elec. & Mfg. Co., E. Pgh
Wheelco Instruments Co., Chicago, Ill.

FURNACE TRAYS [211]
Alloy Casting Co., Champaign, Ill.
Amer. Mang. Steel Div., American Br Shoe Co., Chicago Hts.
Audubon Wire Cloth Corp., Philadelphi
Binney Castings Co., Toledo
Calorizing Co., Pittsburgh, Pa.
Carborundum Co., Niagara Falls, N. Y.
Chicago Steel Foundry Co., Chicago, I
Driver-Harris Co., Harrison, N. J.
Duraloy Co., Scottdale, Pa.
Electro Ref. & Alloys Corp., Buffalo
Fahralloy Co., Harvey, Ill.
General Alloys Co., Boston, Mass.
Hoskins Mfg. Co., Detroit
Johns-Manville, New York
Michiana Prod. Corp., Michigan City, I
Michigan Steel Casting Co., Detroit
Midvale Co., Philadelphia
National Carbon Co., Inc., New York
Ohio Steel Foundry Co., Springfield, O
Rolock, Inc., Fairfield, Conn.
Standard Alloy Co., Cleveland
Sterling-Alloys, Inc., Woburn, Mass.
Tate-Jones & Co., Inc., Leetsdale, Pa.
W. S. Tyler Co., Cleveland
Vulcan Corp., Philadelphia, Pa.

NACE TUBES & MUFFLES [212]
y Casting Co., Champaign, Ill.
y Mfg. Co., Inc., Pittsburgh, Pa.
r. Gas Furnace Co., Elizabeth, N. J.
r. Mang. Steel Div., American Brake
Shoe Co., Chicago Hts.
ler-Morton Co., Pittsburgh, Pa.
rell Technical Supply Co., Pittsburgh
corundum Co., Perth Amboy, N. J.
cago Steel Foundry Co., Chicago, Ill.
ntinental Industrial Eng'rs, Chicago
ry W. Dietert Co., Detroit
ver-Harris Co., Harrison, N. J.
aloy Co., Scottdale, Pa.
rbach & Son Co., Ann Arbor, Mich.
ctro Alloys Co., Elyria, Ohio
ctro Refract. & Alloys Corp., Buffalo
hralloy Co., Harvey, Ill.
neral Alloys Co., Boston, Mass.
aud S. Gordon Co., Chicago, Ill.
vi Duty Electric Co., Milwaukee, Wis.
kins Mfg. Co., Detroit
M. Kemp Mfg. Co., Baltimore, Md.
liana Prod. Corp., Michigan City, Ind.
chigan Steel Casting Co., Detroit
dvale Co., Philadelphia
rton Co., Worcester, Mass.
io Steel Foundry Co., Springfield, Ohio
essed Steel Co., Wilkes-Barre, Pa.
S. Rockwell Co., New York
ndard Alloy Co., Cleveland
erling-Alloys, Inc., Woburn, Mass.
rface Combustion, Toledo, Ohio
te-Jones & Co., Inc., Leetsdale, Pa.
lcan Corp., Philadelphia, Pa.

URNACES—Aluminum Melting [213]
ux Elec. Furnace Corp., Philadelphia
ux Electrothermic Corp., Trenton, N. J.
ux Engineering Corp., Trenton, N. J.
ux Metal Co., Philadelphia
erican Electric Furnace Co., Boston
mer. Gas Furnace Co., Elizabeth, N. J.
rkling Fuel Engineering Co., Chicago
mpbell-Hausfeld Co., Harrison, Ohio
icago Flexible Shaft Co., Chicago, Ill.
icago Steel Foundry Co., Chicago, Ill.
ntinental Industrial Engineers, Chicago
mpsey Ind. Fur. Corp., Springfield, Mass.
troit Elec. Furn. Div., Bay City, Mich.
lipse Fuel Engineering Co., Rockford, Ill.
K. Epstein Co., Springfield, Mass.
her Furnace Co., Chicago
aud S. Gordon Co., Chicago, Ill.
lcroft & Co., Detroit, Mich.
F. Holden Co., New Haven, Conn.
arles A. Hones, Inc., Baldwin, N. Y.
ustrial Heating Equip. Co., Detroit
hnson Gas Apl. Co., Cedar Rapids, Ia.
mes H. Knapp Co., Los Angeles
nsing Engineering Co., Lansing, Mich.
pel High Freq. Labs., Inc., New York
hr Manufacturing Co., Minneapolis
axon Premix Burner Co., Muncie, Ind.
onarch Engineering & Mfg. Co., Balti-
more, Md.
orrison Engineering Co., Inc., Cleveland
tersen Oven Co., Chicago
ttsburgh Lectromelt Furnace Corp.,
Pittsburgh, Pa.
-S Products Corp., Philadelphia, Pa.
diant Combustion, Inc., Warren, O.
. S. Rockwell Co., New York
lem Engineering Co., Salem, Ohio
andard Fuel Engineering Co., Detroit
rface Combustion, Toledo, Ohio
te-Jones & Co., Inc., Leetsdale, Pa.
. S. Smelting Furnace Co., Belleville, Ill.
lcan Corp., Philadelphia, Pa.
e Wilson Engrg. Co., Cleveland, Ohio

URNACES—Atmosphere Controlled [214]
Ajax Electric Co., Inc., Philadelphia
American Electric Furnace Co., Boston
Amer. Gas Furnace Co., Elizabeth, N. J.
Barkling Fuel Engineering Co., Chicago
Bellevue Industrial Furnace Co., Detroit
Case Hardening Service Co., Cleveland
Chicago Flexible Shaft Co., Chicago, Ill.
Continental Industrial Engineers, Chicago
Delaware Tool Steel Corp., Wilmington, Del.
Dempsey Ind. Fur. Corp., Springfield, Mass.
Drever Co., Philadelphia, Pa.
Electric Furnace Co., Salem, O.
M. K. Epstein Co., Springfield, Mass.
Flinn & Dreffein Co., Chicago, Ill.
Gas Machinery Co., Cleveland
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago, Ill.
Harper Elec. Furn. Corp., Niagara Falls
C. I. Hayes, Inc., Providence, R. I.
Hevi Duty Electric Co., Milwaukee, Wis.
Holcroft & Co., Detroit, Mich.
A. F. Holden Co., New Haven, Conn.
Charles A. Hones, Inc., Baldwin, N. Y.
C. M. Kemp Mfg. Co., Baltimore, Md.
C. F. Kenworthy, Inc., Waterbury, Conn.
James H. Knapp Co., Los Angeles
Lansing Engineering Co., Lansing, Mich.
Leeds & Northrup Co., Philadelphia, Pa.
Lindberg Engineering Co., Chicago, Ill.
Lithium Co., Newark, N. J.
Mahr Mfg. Co., Minneapolis, Minn.
G. S. Peterson Co., Cleveland
R-S Products Corp., Philadelphia, Pa.
W. S. Rockwell Co., New York
Salem Engineering Co., Salem, Ohio
Sargent & Wilbur, Pawtucket, R. I.
Sentry Co., Foxboro, Mass.
Surface Combustion, Toledo, Ohio
Sweden Freezer Mfg. Co., Seattle, Wash.
Swindell-Dressler Corp., Pittsburgh
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia, Pa.
Westinghouse Elec. & Mfg. Co., E. Pgh.
Lee Wilson Engrg. Co., Cleveland, Ohio

FURNACES—Bell Type [215]
American Electric Furnace Co., Boston
Amer. Gas Furnace Co., Elizabeth, N. J.
Bellis Heat Treating Co., Branford, Conn.
Continental Industrial Engineers, Chicago
Dempsey Ind. Fur. Corp., Springfield, Mass.
Eclipse Fuel Engin'g Co., Rockford, Ill.
Electric Furnace Co., Salem, O.
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago, Ill.
Holcroft & Co., Detroit, Mich.
R-S Products Corp., Philadelphia, Pa.
W. S. Rockwell Co., New York
Salem Engineering Co., Salem, Ohio
Surface Combustion, Toledo, Ohio
Swindell-Dressler, Pittsburgh
Tate-Jones & Co., Inc., Leetsdale, Pa.
Harold E. Trent Co., Philadelphia, Pa.
Vulcan Corp., Philadelphia, Pa.
Westinghouse Elec. & Mfg. Co., E. Pgh.
Lee Wilson Engrg. Co., Cleveland, Ohio

FURNACES—Billet, Ingot Heating [216]
Ajax Electrothermic Corp., Trenton, N. J.
Amer. Electric Furnace Co., Boston
Amsler Morton Co., Pittsburgh
Barkling Fuel Engineering Co., Chicago
Budd Induction Heating, Inc., Detroit
Carl-Mayer Corp., Cleveland
Chicago Flexible Shaft Co., Chicago, Ill.
Continental Industrial Engineers, Chicago
Dempsey Ind. Fur. Corp., Springfield, Mass.
Despatch Oven Co., Minneapolis, Minn.
Eclipse Fuel Engineering Co., Rockford, Ill.
Electric Furnace Co., Salem, O.
M. K. Epstein Co., Springfield, Mass.
Flinn & Dreffein Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago, Ill.
George J. Hagan Co., Pittsburgh
Holcroft & Co., Detroit
James H. Knapp Co., Los Angeles
Lansing Engineering Co., Lansing, Mich.
Paul Maehler Co., Chicago
Mahr Mfg. Co., Minneapolis, Minn.
R-S Products Corp., Philadelphia, Pa.
W. S. Rockwell Co., New York
Salem Engineering Co., Salem, Ohio
Surface Combustion, Toledo, Ohio
Swindell-Dressler, Pittsburgh
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia, Pa.
Lee Wilson Engrg. Co., Cleveland, Ohio
Young Brothers Co., Detroit

FURNACES—Brass Melting [217]
Acme Furnace Co., Chicago
Ajax Elec. Furnace Corp., Philadelphia
Ajax Electrothermic Corp., Trenton, N. J.
Amer. Gas Furnace Co., Elizabeth, N. J.
Amsler-Morton Co., Pittsburgh, Pa.
Campbell-Hausfeld Co., Harrison, Ohio
Chicago Flexible Shaft Co., Chicago, Ill.
Continental Industrial Engineers, Chicago
Dempsey Ind. Fur. Corp., Springfield, Mass.
Det. Elec. Furnace Div., Bay City, Mich.
Eclipse Fuel Engineering Co., Rockford, Ill.
Fisher Furnace Co., Chicago
Claud S. Gordon Co., Chicago, Ill.
James H. Knapp Co., Los Angeles
Lepel High Freq. Labs., Inc., New York
Mahr Manufacturing Co., Minneapolis
Maxon Premix Burner Co., Muncie, Ind.
Monarch Engineering & Mfg. Co., Balti-
more, Md.
Petersen Oven Co., Chicago
R-S Products Corp., Philadelphia, Pa.
W. S. Rockwell Co., New York
Standard Fuel Engineering Co., Detroit
Surface Combustion, Toledo, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.
U. S. Smelting Furnace Co., Belleville, Ill.
Vulcan Corp., Philadelphia

FURNACES—Bright Annealing [218]
Ajax Electric Co., Inc., Philadelphia
American Electric Furnace Co., Boston
Amer. Gas Furnace Co., Elizabeth, N. J.
Bellevue Industrial Furnace Co., Detroit
Bellis Heat Treating Co., Branford, Conn.
Case Hardening Service Co., Cleveland
Chicago Flexible Shaft Co., Chicago, Ill.
Continental Industrial Engineers, Chicago
Dempsey Ind. Fur. Corp., Springfield, Mass.
Despatch Oven Co., Minneapolis, Minn.
Drever Co., Philadelphia, Pa.
Electric Furnace Co., Salem, O.
M. K. Epstein Co., Springfield, Mass.
Flinn & Dreffein Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago, Ill.
C. I. Hayes, Inc., Providence, R. I.
Hevi Duty Electric Co., Milwaukee, Wis.
Holcroft & Co., Detroit, Mich.
A. F. Holden Co., New Haven, Conn.
C. M. Kemp Mfg. Co., Baltimore, Md.
Charles F. Kenworthy, Waterbury, Conn.
James H. Knapp Co., Los Angeles
Lansing Engineering Co., Lansing, Mich.
Lindberg Engineering Co., Chicago, Ill.
Lithium Co., Newark, N. J.
Mahr Mfg. Co., Minneapolis, Minn.
Morrison Engrg. Co., Cleveland
R-S Products Corp., Philadelphia, Pa.
W. S. Rockwell Co., New York
Salem Engineering Co., Salem, Ohio
Sargent & Wilbur, Pawtucket, R. I.
Surface Combustion, Toledo, Ohio
Swindell-Dressler Corp., Pittsburgh
Tate-Jones & Co., Inc., Leetsdale, Pa.
Harold E. Trent Co., Philadelphia, Pa.
Vulcan Corp., Philadelphia
Wean Engineering Co., Inc., Warren, Ohio
Westinghouse Elec. & Mfg. Co., E. Pgh.
Lee Wilson Engrg. Co., Cleveland, Ohio

FURNACES—Burner Equipment [219]
Amer. Gas Furnace Co., Elizabeth, N. J.
Amsler-Morton Co., Pittsburgh
Dempsey Ind. Fur. Corp., Springfield, Mass.
Driver-Harris Co., Harrison, N. J.
Eclipse Fuel Engineering Co., Rockford, Ill.
M. K. Epstein Co., Springfield, Mass.
Flinn & Dreffein Co., Chicago, Ill.
E. A. Furkert Co., Chicago, Ill.
Claud S. Gordon Co., Chicago, Ill.
Hauck Mfg. Co., Brooklyn, N. Y.
Charles A. Hones, Inc., Baldwin, N. Y.
C. M. Kemp Mfg. Co., Baltimore, Md.
James H. Knapp Co., Los Angeles
Mahr Manufacturing Co., Minneapolis
Maxon Premix Burner, Muncie, Ind.
Morrison Engineering Co., Inc., Cleveland
National Machine Works, Chicago
Partlow Corp., New Hartford, N. Y.
Preferred Utilities Co., New York
R-S Products Corp., Philadelphia, Pa.
W. S. Rockwell Co., New York
Standard Fuel Engineering Co., Detroit
Surface Combustion, Toledo, Ohio
Swindell-Dressler Corp., Pittsburgh, Pa.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia
Lee Wilson Engrg. Co., Cleveland, Ohio

FURNACES—Car Type [220]
Amer. Electric Furnace Co., Boston
Amsler-Morton Co., Pittsburgh, Pa.
Bell & Gossett Co., Chicago, Ill.
Bellevue Industrial Furnace Co., Detroit
Carl-Mayer Corp., Cleveland
Chicago Flexible Shaft Co., Chicago, Ill.
Continental Industrial Eng., Inc., Chicago
Dempsey Ind. Fur. Corp., Springfield, Mass.
Despatch Oven Co., Minneapolis, Minn.
Drever Co., Philadelphia, Pa.
Electric Furnace Co., Salem, O.
M. K. Epstein Co., Springfield, Mass.
Flinn & Dreffein Co., Chicago, Ill.
Gas Machinery Co., Cleveland
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago, Ill.
George J. Hagan Co., Pittsburgh
Hevi Duty Electric Co., Milwaukee, Wis.
Holcroft & Co., Detroit, Mich.
Industrial Heating Equipment Co., Detroit
Industrial Oven Engrg. Co., Cleveland
Charles F. Kenworthy, Waterbury, Conn.

James H. Knapp Co., Los Angeles
Lansing Engineering Co., Lansing, Mich.
Lindberg Engineering Co., Chicago
Paul Maehler Co., Chicago
Mahr Manufacturing Co., Minneapolis
Morrison Engineering Corp., Cleveland
R-S Products Corp., Philadelphia, Pa.
Radiant Combustion, Inc., Warren, Ohio
W. S. Rockwell Co., New York
Salem Engineering Co., Salem, Ohio
Standard Fuel Engineering Co., Detroit
Surface Combustion, Toledo, Ohio
Swindell-Dressler Corp., Pittsburgh
Harold E. Trent Co., Philadelphia, Pa.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia
Lee Wilson Engrg. Co., Cleveland, Ohio
Young Brothers Co., Detroit

FURNACES—Copper Brazing [221]
Ajax Electric Co., Inc., Philadelphia
Ajax Electrothermic Corp., Trenton, N. J.
American Electric Furnace Co., Boston
Amer. Gas Furnace Co., Elizabeth, N. J.
Bellis Heat Treat. Co., Branford, Conn.
Continental Industrial Engineers, Chicago
Dempsey Ind. Fur. Corp., Springfield, Mass.
Drever Co., Philadelphia, Pa.
Electric Furnace Co., Salem, O.
Eutectic Welding Alloys, Inc., New York
Firth-Sterling Steel Co., McKeesport, Pa.
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago
Harper Elec. Fur. Corp., Niagara Falls, N. Y.
C. I. Hayes, Inc., Providence, R. I.
Hevi Duty Electric Co., Milwaukee, Wis.
A. F. Holden Co., New Haven, Conn.
Johnson Gas Appl. Co., Cedar Rapid, Ia.
Lepel High Freq. Labs., Inc., New York
Lindberg Engineering Co., Chicago, Ill.
Lithium Co., Newark, N. J.
Morrison Engineering Co., Cleveland
R-S Products Corp., Philadelphia, Pa.
W. S. Rockwell Co., New York
Salem Engineering Co., Salem, Ohio
Sargent & Wilbur, Pawtucket, R. I.
Sentry Co., Foxboro, Mass.
Surface Combustion, Toledo, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.
Upton Electric Furnace Div., Commerce Pattern Foundry & Mach. Co., Detroit
Vulcan Corp., Philadelphia
Westinghouse Electric & Mfg. Co., E. Pgh.

FURNACES—Electric Heat Treating [222]
Ajax Electric Co., Inc., Philadelphia
Ajax Electrothermic Corp., Trenton, N. J.
Ajax Metal Co., Philadelphia
American Car & Foundry Co., New York
American Electric Furnace Co., Boston
Bell & Gossett Co., Chicago, Ill.
Bellis Heat Treating Co., Branford, Conn
Carl-Mayer Corp., Cleveland
Case Hardening Service Co., Cleveland
Continental Industrial Engineers, Chicago
Delaware Tool Steel Corp., Wilmington, Del.
Despatch Oven Co., Minneapolis, Minn.
Drever Co., Philadelphia, Pa.
Ecco High Frequency Elec. Corp., No. Bergen, N. J.
Eimer & Amend, New York
Electric Furnace Co., Salem, O.
Falls Elec. Furn. Corp., Buffalo, N. Y.
Federal Tel. & Radio Corp., Newark, N. J.
Fisher Scientific Co., Pittsburgh
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago, Ill.
George J. Hagan Co., Pittsburgh
Harper Elec. Furn. Corp., Niagara Falls
C. I. Hayes, Inc., Providence, R. I.
Hevi Duty Electric Co., Milwaukee, Wis.
Holcroft & Co., Detroit, Mich.
A. F. Holden Co., New Haven, Conn.
Hoskins Mfg. Co., Detroit, Mich.
Induction Heating Corp., New York
Industrial Oven Engrg. Co., Cleveland
Charles F. Kenworthy, Waterbury, Conn.
James H. Knapp Co., Los Angeles
Lansing Engineering Co., Lansing, Mich.
Leeds & Northrup Co., Philadelphia, Pa.
Lepel High Freq. Labs., Inc., New York
Lindberg Engineering Co., Chicago, Ill.
Lithium Co., Newark, N. J.
Mahr Mfg. Co., Minneapolis, Minn.
Morrison Engineering Co., Inc., Cleveland
Ohio Crankshaft Co., Cleveland, Ohio
Pereny Equipment Co., Columbus
G. S. Peterson Co., Cleveland
R-S Products Corp., Philadelphia, Pa.
Radiant Combustion, Inc., Warren, Ohio
Radio Corp. of America—RCA Victor Div., Camden, N. J.
W. S. Rockwell Co., New York
J. O. Ross Engineering Corp., N. Y. City
Salem Engineering Co., Salem, Ohio
Sargent & Wilbur, Pawtucket, R. I.
Sentry Co., Foxboro, Mass.
Swindell-Dressler Corp., Pittsburgh
H. O. Swoboda, Inc., New Brighton, Pa.
Harold E. Trent Co., Philadelphia, Pa.
Upton Electric Furnace Div., Commerce Pattern Foundry & Mach. Co., Detroit
Van Norman Mach. Tool Co., Sp'gf'd, Mass.
Vulcan Corp., Philadelphia
Westinghouse Electric & Mfg. Co., E. Pgh.
Lee Wilson Engineering Co., Cleveland
Young Brothers Co., Detroit

FURNACES—Electric, Steel Melting [223]
Ajax Electrothermic Corp., Trenton, N. J.
American Bridge Co., Pittsburgh, Pa.
Chicago Flexible Shaft Co., Chicago, Ill.
Continental Industrial Engineers, Chicago
Det. Elec. Furnace Div., Bay City, Mich.
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago
Lepel High Freq. Labs., Inc., New York
Pgh. Lect. Furnace Corp., Pittsburgh
R-S Products Corp., Philadelphia, Pa.
Swindell-Dressler Corp., Pittsburgh

FURNACES—Forging [224]
Ajax Electric Co., Inc., Philadelphia
Ajax Electrothermic Corp., Trenton, N. J.
American Car & Foundry Co., New York
American Electric Furnace Co., Boston
Amer. Gas Furnace Co., Elizabeth, N. J.
Amsler-Morton Co., Pittsburgh, Pa.
Barkling Fuel Engineering Co., Chicago
Bellis Heat Treat. Co., Branford, Conn.
Carl-Mayer Corp., Cleveland
Chicago Flexible Shaft Co., Chicago, Ill.
Continental Industrial Engineers, Chicago
Dempsey Ind. Fur. Corp., Springfield, Mass.
Despatch Oven Co., Minneapolis, Minn.
Drever Co., Philadelphia, Pa.
Ecco High Frequency Elec. Corp., No. Bergen, N. J.
Eclipse Fuel Engineering Co., Rockford, Ill.
Electric Furnace Co., Salem, O.
M. K. Epstein Co., Springfield, Mass.
Flinn & Dreffein Co., Chicago, Ill.
Gas Machinery Co., Cleveland
Claud S. Gordon Co., Chicago, Ill.
George J. Hagan Co., Pittsburgh
Holcroft & Co., Detroit, Mich.
A. F. Holden Co., New Haven, Conn.
Charles A. Hones, Inc., Baldwin, N. Y.
Charles F. Kenworthy, Waterbury, Conn.
James H. Knapp Co., Los Angeles
Lansing Engineering Co., Lansing, Mich.
Lepel High Freq. Labs., Inc., New York
Mahr Manufacturing Co., Minneapolis
Morrison Engineering Co., Cleveland
R-S Products Corp., Philadelphia, Pa.
Radiant Combustion, Inc., Warren, Ohio
W. S. Rockwell Co., New York
Salem Engineering Co., Salem, Ohio
Standard Fuel Engineering Co., Detroit
Surface Combustion, Toledo, Ohio
Swindell-Dressler Corp., Pittsburgh
Tate-Jones & Co., Inc., Leetsdale, Pa.
Upton Electric Furnace Div., Commerce Pattern Foundry & Mach. Co., Detroit
Vulcan Corp., Philadelphia
Lee Wilson Engrg. Co., Cleveland, Ohio

FURNACES—Gray Iron Melting [225]
American Bridge Co., Pittsburgh, Pa.
Amsler-Morton Co., Pittsburgh, Pa.
Continental Industrial Engineers, Chicago
Detroit Electric Furnace Div., Kuhlman Electric Co., Bay City, Mich.
Claud S. Gordon Co., Chicago
Pittsburgh Lectromelt Furnace Corp., Pittsburgh, Pa.
Swindell-Dressler Corp., Pittsburgh, Pa.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Whiting Corp., Harvey, Ill.

FURNACES—Heat Treating, Cyanide or Lead [226]
Acme Furnace Co., Chicago
Ajax Electric Co., Inc., Philadelphia
American Electric Furnace Co., Boston
Amer. Gas Furnace Co., Elizabeth, N. J.
Barkling Fuel Engineering Co., Chicago
Bell & Gossett Co., Chicago, Ill.
Bellis Heat Treating Co., Branford, Conn.
Case Hardening Service Co., Cleveland
Chicago Flexible Shaft Co., Chicago, Ill.
Continental Industrial Engineers, Chicago
Dempsey Ind. Fur. Corp., Springfield, Mass.
Drever Co., Philadelphia, Pa.
Electric Furnace Co., Salem, O.
M. K. Epstein Co., Springfield, Mass.
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago, Ill.
Hevi Duty Electric Co., Milwaukee, Wis.
Holcroft & Co., Detroit
A. F. Holden Co., New Haven, Conn.
Charles A. Hones, Inc., Baldwin, N. Y.
Hoskins Mfg. Co., Detroit, Mich.
Indus. Heating Equip. Co., Detroit, Mich.
Johnson Gas Appl. Co., Cedar Rapids, Ia.
James H. Knapp Co., Los Angeles
Lansing Engineering Co., Lansing, Mich.
Lindberg Engineering Co., Chicago, Ill.
Mahr Manufacturing Co., Minneapolis
Morrison Engineering Co., Cleveland
G. S. Peterson Co., Cleveland, Ohio
R-S Products Corp., Philadelphia, Pa.
Radiant Combustion, Inc., Warren, Ohio
W. S. Rockwell Co., New York
Sentry Co., Foxboro, Mass.
Standard Fuel Engineering Co., Detroit
Surface Combustion, Toledo, Ohio
H. O. Swoboda, Inc., New Brighton, Pa.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Harold E. Trent Co., Philadelphia, Pa.
Upton Electric Furnace Div., Commerce Pattern Foundry & Mach. Co., Detroit
Vulcan Corp., Philadelphia
Lee Wilson Engrg. Co., Cleveland, Ohio

FURNACES—Heat Treating, Gas [227]
American Electric Furnace Co., Boston
American Gas Assn., New York
Amer. Gas Furnace Co., Elizabeth, N. J.
Amsler-Morton Co., Pittsburgh, Pa.
Baker & Co., Newark, N. J.
Carl-Mayer Corp., Cleveland, Ohio
Case Hardening Service Co., Cleveland
Chicago Flexible Shaft Co., Chicago, Ill.
Continental Industrial Engineers, Chicago
Delaware Tool Steel Corp., Wilmington, Delaware
Dempsey Ind. Fur. Corp., Springfield, Mass.
Despatch Oven Co., Minneapolis, Minn.
Drever Co., Philadelphia, Pa.
Eclipse Fuel Engineering Co., Rockford, Ill.
Electric Furnace Co., Salem, O.
M. K. Epstein Co., Springfield, Mass.
Flinn & Dreffein Co., Chicago, Ill.
Gehnrich Corp., Long Island City, N. Y.
Claud S. Gordon Co., Chicago, Ill.
George J. Hagan Co., Pittsburgh
Hevi Duty Electric Co., Milwaukee, Wis.
Holcroft & Co., Detroit, Mich.
A. F. Holden Co., New Haven, Conn.
Charles A. Hones, Inc., Baldwin, N. Y.
Indus. Heating Equip. Co., Detroit, Mich.
Industrial Oven Engrg. Co., Cleveland
Johnson Gas Appl. Co., Cedar Rapids, Ia.
C. M. Kemp Mfg. Co., Baltimore, Md.
C. F. Kenworthy, Inc., Waterbury, Conn.
James H. Knapp Co., Los Angeles
Lanly Co., Cleveland
Lansing Engineering Co., Lansing, Mich.
Lindberg Engineering Co., Chicago, Ill.
Lithium Co., Newark, N. J.
Paul Maehler Co., Chicago
Mahr Manufacturing Co., Minneapolis
Morrison Engineering Co., Inc., Cleveland
R-S Products Corp., Philadelphia, Pa.
Radiant Combustion, Inc., Warren, Ohio
W. S. Rockwell Co., New York
Salem Engineering Co., Salem, Ohio
Selas Co., Philadelphia, Pa.
Sellers Engineering Co., Chicago
Standard Fuel Engineering Co., Detroit
Surface Combustion, Toledo, Ohio
Swindell-Dressler Corp., Pittsburgh
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia
Lee Wilson Engrg. Co., Cleveland, Ohio
Young Brothers Co., Detroit

FURNACES—Heat Treating, Oil or G [228]
Acme Furnace Co., Chicago, Ill.
Amer. Gas Furnace Co., Elizabeth, N. J.
Amsler-Morton Co., Pittsburgh, Pa.
Carl-Mayer Corp., Cleveland, Ohio
Case Hardening Service Co., Cleveland
Chicago Flexible Shaft Co., Chicago, Ill.
Continental Industrial Engineers, Chicago
Dempsey Ind. Fur. Corp., Springfield, Mass.
Despatch Oven Co., Minneapolis, Minn.
Drever Co., Philadelphia, Pa.
Electric Furnace Co., Salem, O.
M. K. Epstein Co., Springfield, Mass.
Flinn & Dreffein Co., Chicago, Ill.
Foundry Equipment Co., Cleveland
Gas Machinery Co., Cleveland
Gehnrich Corp., Long Island City, N. Y.
Claud S. Gordon Co., Chicago, Ill.
George J. Hagan Co., Pittsburgh

See Advertisement of Companies in Bold-Face Type for Further Information

roft & Co., Detroit, Mich.
F. Holden Co., New Haven, Conn.
dus. Heating Equip. Co., Detroit, Mich.
ustrial Oven Engrg. Co., Cleveland
mes H. Knapp Co., Los Angeles
rles F. Kenworthy, Waterbury, Conn.
ly Co., Cleveland
sing Engineering Co., Lansing, Mich.
berg Engineering Co., Chicago, Ill.
ium Co., Newark, N. J.
l Maehler Co., Chicago
hr Manufacturing Co., Minneapolis
rrison Engineering Co., Inc., Cleveland
S. Peterson Co., Cleveland, Ohio
S Products Corp., Philadelphia, Pa.
diant Combustion, Inc., Warren, Ohio
S. Rockwell Co., New York
O Ross Engineering Corp., N. Y. City
en Engineering Co., Salem, Ohio
ndard Fuel Engineering Co., Detroit
face Combustion, Toledo, Ohio
indell-Dressler Corp., Pittsburgh, Pa.
e-Jones & Co., Inc., Leetsdale, Pa.
on Corp., Philadelphia
n Wilson Engrg. Co., Cleveland, Ohio

RNACES—High Speed St. Hard. [229]
ce Furnace Co., Chicago, Ill.
ic Electric Co., Inc., Philadelphia
ax Metal Co., Philadelphia
erican Electric Furnace Co., Boston
er. Gas Furnace Co., Elizabeth, N. J.
sler-Morton Co., Pittsburgh, Pa.
el & Gossett Co., Chicago, Ill.
ns Heat Treating Co., Branford, Conn.
e Hardening Service Co., Cleveland
icago Flexible Shaft Co., Chicago, Ill.
ntinental Industrial Engineers, Chicago
laware Tool Steel Corp., Wilmington, Del.
mpsey Ind. Fur. Corp., Springfield, Mass.
spatch Oven Co., Minneapolis, Minn.
ever Co., Philadelphia
lipse Fuel Engineering Co., Rockford, Ill.
M. K. Epstein Co., Springfield, Mass.
neral Electric Co., Schenectady, N. Y.
aud S. Gordon Co., Chicago, Ill.
. I. Hayes, Inc., Providence, R. I.
vi Duty Electric Co., Milwaukee, Wis.
A. F. Holden Co., New Haven, Conn.
arles A. Hones, Inc., Baldwin, N. Y.
dus. Heating Equip. Co., Detroit, Mich.
nson Gas Appl. Co., Cedar Rapids, Iowa
mes H. Knapp Co., Los Angeles
nsing Engineering Co., Lansing, Mich.
dberg Engineering Co., Chicago, Ill.
ax Manufacturing Co., Minneapolis
rrison Engineering Co., Cleveland
ney Equipment Co., Columbus, O.
S Products Corp., Philadelphia, Pa.
S. Rockwell Co., New York
ntry Co., Foxboro, Mass.
rface Combustion, Toledo, Ohio
le-Jones & Co., Inc., Leetsdale, Pa.
ton Electric Furnace Div., Commerce
Pattern Foundry & Mach. Co., Detroit
lcan Corp., Philadelphia

RNACES—Heat., Continuous [230]
ax Electric Co., Inc., Philadelphia
erican Electric Furnace Co., Boston
er. Gas Furnace Co., Elizabeth, N. J.
sler-Morton Co., Pittsburgh, Pa.
llevue Industrial Furnace Co., Detroit
l-Mayer Corp., Cleveland, Ohio
e Hardening Service Co., Cleveland
icago Flexible Shaft Co., Chicago, Ill.
ntinental Industrial Engineers, Chicago
mpsey Ind. Fur. Corp., Springfield, Mass.
spatch Oven Co., Minneapolis, Minn.
ever Co., Philadelphia, Pa.
lipse Fuel Engineering Co., Rockford, Ill.
ctric Furnace Co., Salem, O.
M. K. Epstein Co., Springfield, Mass.
nn & Dreffein Co., Chicago, Ill.
neral Electric Co., Schenectady, N. Y.
aud S. Gordon Co., Chicago, Ill.
. I. Hayes, Inc., Providence, R. I.
olcroft & Co., Detroit, Mich.
A. F. Holden Co., New Haven, Conn.
dus. Heating Equip. Co., Detroit, Mich.
dustrial Oven Engrg. Co., Cleveland
mes H. Knapp Co., Los Angeles
nsing Engineering Co., Lansing, Mich.
dberg Engineering Co., Chicago, Ill.
thium Co., Newark, N. J.
el Maehler Co., Chicago
ahr Manufacturing Co., Minneapolis
rrison Engineering Co., Inc., Cleveland
. S. Peterson Co., Cleveland, Ohio
S Products Corp., Philadelphia, Pa.
diant Combustion, Inc., Warren, Ohio
. S. Rockwell Co., New York
Salem Engineering Co., Salem, Ohio
Sargent & Wilbur, Pawtucket, R. I.
Standard Fuel Engineering Co., Detroit
Surface Combustion, Toledo, Ohio
Sweden Freezer Mfg. Co., Seattle, Wash.
Swindell-Dressler Corp., Pittsburgh, Pa.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Upton Electric Furnace Div., Commerce Pattern Foundry & Mach. Co., Detroit
Vulcan Corp., Philadelphia
Westinghouse Electric & Mfg. Co., E. Pgh.
Lee Wilson Engrg. Co., Cleveland, Ohio
Young Brothers Co., Detroit

FURNACES—Induction [231]
Ajax Elec. Furnace Corp., Philadelphia
Ajax Electrothermic Corp., Trenton, N. J.
Ajax Engineering Corp., Trenton, N. J.
Budd Induction Heating, Inc., Detroit
Continental Industrial Engineers, Chicago
Dempsey Ind. Fur. Corp., Springfield, Mass.
Despatch Oven Co., Minneapolis, Minn.
Ecco High Frequency Corp., New York
M. K. Epstein Co., Springfield, Mass.
Claud S. Gordon Co., Chicago, Ill.
Induction Heating Corp., New York
Lansing Engineering Co., Lansing, Mich.
Lepel High Freq. Labs., Inc., New York
Morrison Engineering Co., Cleveland
Ohio Crankshaft Co., Cleveland, Ohio
Radio Corp. of America—RCA Victor Div., Camden, N. J.
Stewart Furnace Div., Chicago Flex. Shaft Co., Chicago
Van Norman Mach. Tool Co., Sp'gf'd, Mass.
Westinghouse Elec. & Mfg. Co., E. Pgh.

FURNACES—Laboratory [232]
Ajax Electrothermic Corp., Trenton, N. J.
American Electric Furnace Co., Boston
Amer. Gas Furnace Co., Elizabeth, N. J.
American Inst. Co., Silver Spring, Md.
Baker & Co., Newark, N. J.
Bellis Heat Treating Co., Branford, Conn.
Burrell Technical Supply Co., Pittsburgh
Campbell-Hausfeld Co., Harrison, Ohio
Case Hardening Service Co., Cleveland
Central Scientific Co., Chicago, Ill.
Del. Tool Steel Corp., Wilmington, Del.
Dempsey Ind. Fur. Corp., Springfield, Mass.
Despatch Oven Co., Minneapolis, Minn.
Detroit Elec. Furn. Div., Bay City, Mich.
Harry W. Dietert Co., Detroit, Mich.
Eberbach & Son Co., Ann Arbor, Mich.
Ecco High Frequency Corp., New York
Eclipse Fuel Engineering Co., Rockford, Ill.
Eimer & Amend, New York
Falls Electric Furnace Corp., Buffalo
Fisher Scientific Co., Pittsburgh
E. A. Furkert Co., Chicago
Claud S. Gordon Co., Chicago, Ill.
Harper Elec. Furn. Corp., Niagara Falls
Hevi Duty Electric Co., Milwaukee, Wis.
A. F. Holden Co., New Haven, Conn.
Charles A. Hones, Inc., Baldwin, N. Y.
Hoskins Mfg. Co., Detroit, Mich.
Johnson Gas Appl. Co., Cedar Rapids, Iowa
Leeds & Northrup Co., Philadelphia, Pa.
Lindberg Engineering Co., Chicago, Ill.
Mahr Manufacturing Co., Minneapolis
Maxon Premix Burner Co., Muncie, Ind.
Pereny Equipment Co., Columbus, O.
Pittsburgh Lectromelt Furn. Corp., Pittsburgh, Pa.
Precision Scientific Co., Chicago
W. S. Rockwell Co., New York
E. H. Sargent & Co., Chicago, Ill.
Sentry Co., Foxboro, Mass.
Surface Combustion, Toledo, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.
Thwing-Albert Instrument Co., Phila., Pa.
Upton Electric Furnace Div., Commerce Pattern Foundry & Mach. Co., Detroit

FURNACES—Magnesium Melting [233]
Ajax Electrothermic Corp., Trenton, N. J.
Ajax Metal Co., Philadelphia
Campbell-Hausfeld Co., Harrison, Ohio
Chicago Flexible Shaft Co., Chicago
Continental Industrial Engineers, Chicago
Dempsey Ind. Fur. Corp., Springfield, Mass.
Detroit Elec. Furn. Div., Bay City, Mich.
Eclipse Fuel Engineering Co., Rockford, Ill.
Electro Ref. & Alloys Corp., Buffalo
Fisher Furnace Co., Chicago, Ill.
Claud S. Gordon Co., Chicago
Charles A. Hones, Inc., Baldwin, N. Y.
Hoskins Mfg. Co., Detroit, Mich.
James H. Knapp Co., Los Angeles
Lansing Engineering Co., Lansing, Mich.
Mahr Manufacturing Co., Minneapolis
Monarch Engr. & Mfg. Co., Baltimore
Morrison Engineering Co., Cleveland
Petersen Oven Co., Chicago
R-S Products Corp., Philadelphia, Pa.
Radiant Combustion, Inc., Warren, Ohio
W. S. Rockwell Co., New York
Selas Co., Philadelphia
Standard Fuel Engineering Co., Detroit
Stewart Furnace Div., Chicago Flex. Shaft Co., Chicago
Surface Combustion, Toledo, Ohio
Swindell-Dressler Corp., Pittsburgh, Pa.
Vulcan Corp., Philadelphia
Lee Wilson Engrg. Co., Cleveland, Ohio

FURNACES—Non-Ferrous Melting [234]
Ajax Electrothermic Corp., Trenton, N. J.
American Electric Furnace Co., Boston
Amer. Gas Furnace Co., Elizabeth, N. J.
Campbell-Hausfeld Co., Harrison, Ohio
Chicago Flexible Shaft Co., Chicago, Ill.
Continental Industrial Engineers, Chicago
Dempsey Ind. Fur. Corp., Springfield, Mass.
Detroit Elec. Furn. Div., Bay City, Mich.
Eclipse Fuel Engineering Co., Rockford, Ill.
M. K. Epstein Co., Springfield, Mass.
Fisher Furnace Co., Chicago, Ill.
Claud S. Gordon Co., Chicago, Ill.
James H. Knapp Co., Los Angeles
Lansing Engineering Co., Lansing, Mich.
Lepel High Freq. Labs., Inc., New York
Lithium Co., Newark, N. J.
Mahr Manufacturing Co., Minneapolis
Monarch Engineering & Mfg. Co., Baltimore, Md.
Petersen Oven Co., Chicago
G. S. Peterson Co., Cleveland, Ohio
Pittsburgh Lectromelt Furnace Corp., Pittsburgh, Pa.
R-S Products Corp., Philadelphia, Pa.
Radiant Combustion, Inc., Warren, Ohio
W. S. Rockwell Co., New York
Sentry Co., Foxboro, Mass.
Surface Combustion, Toledo, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.
U. S. Smelting Furnace Co., Belleville, Ill.
Vulcan Corp., Philadelphia
Lee Wilson Engrg. Co., Cleveland, Ohio

FURNACES—Open Hearth [235]
Amsler-Morton Co., Pittsburgh, Pa.
Continental Industrial Engineers, Chicago
Claud S. Gordon Co., Chicago
Salem Engineering Co., Salem, Ohio
Surface Combustion, Toledo, Ohio
Swindell-Dressler Corp., Pittsburgh, Pa.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia

FURNACES—Pack Heating Sheets [236]
American Electric Furnace Co., Boston
Amsler-Morton Co., Pittsburgh, Pa.
Continental Industrial Engineers, Chicago
Dempsey Ind. Fur. Corp., Springfield, Mass.
Despatch Oven Co., Minneapolis, Minn.
Electric Furnace Co., Salem, O.
Flinn & Dreffein Co., Chicago, Ill.
General Electric, Schenectady, N. Y.
Claud S. Gordon Co., Chicago
Lansing Engineering Co., Lansing, Mich.
R-S Products Corp., Philadelphia
W. S. Rockwell Co., New York
Salem Engineering Co., Salem, Ohio
Sentry Co., Foxboro, Mass.
Surface Combustion, Toledo, Ohio
Swindell-Dressler Corp., Pittsburgh, Pa.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia
Wean Engineering Co., Inc., Warren, Ohio

FURNACES—Recirculating [237]
American Electric Furnace Co., Boston
Bellevue Industrial Furnace Co., Detroit
Carl-Mayer Corp., Cleveland, Ohio
Case Hardening Service Co., Cleveland
Chicago Flexible Shaft Co., Chicago, Ill.
Continental Industrial Engineers, Chicago
Dempsey Ind. Fur. Corp., Springfield, Mass.
Despatch Oven Co., Minneapolis, Minn.
Drever Co., Philadelphia, Pa.
Eclipse Fuel Engineering Co., Rockford, Ill.
Electric Furnace Co., Salem, Ohio
M. K. Epstein Co., Springfield, Mass.
Flinn & Dreffein Co., Chicago, Ill.
Foundry Equipment Co., Cleveland
Gas Machinery Co., Cleveland
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago, Ill.
Holcroft & Co., Detroit, Mich.
A. F. Holden Co., New Haven, Conn.
Indus. Heating Equip. Co., Detroit, Mich.
Industrial Oven Engrg. Co., Cleveland
C. M. Kemp Mfg. Co., Baltimore, Md.
James H. Knapp Co., Los Angeles
Lanly Co., Cleveland

Lansing Engineering Co., Lansing, Mich.
Lindberg Engineering Co., Chicago, Ill.
Lithium Co., Newark, N. J.
Paul Maehler Co., Chicago
Mahr Manufacturing Co., Minneapolis
Morrison Engineering Corp., Cleveland
R-S Products Corp., Philadelphia, Pa.
Radiant Combustion, Inc., Warren, Ohio
W. S. Rockwell Co., New York
Salem Engineering Co., Salem, Ohio
Surface Combustion, Toledo, Ohio
Swindell-Dressler Corp., Pittsburgh, Pa.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Harold E. Trent Co., Philadelphia, Pa.
Vulcan Corp., Philadelphia
Lee Wilson Engrg. Co., Cleveland, Ohio

FURNACES—Salt Bath [238]
Acme Furnace Co., Chicago, Ill.
Ajax Electric Co., Inc., Philadelphia
American Electric Furnace Co., Boston
Amer. Gas Furnace Co., Elizabeth, N. J.
Bellis Heat Treating Co., Branford, Conn.
Case Hardening Service Co., Cleveland
Chicago Flexible Shaft Co., Chicago, Ill.
Chicago Steel Foundry Co., Chicago, Ill.
Continental Industrial Engineers, Chicago
Delaware Tool Steel Corp., Wilmington, Delaware
Dempsey Ind. Fur. Corp., Springfield, Mass.
Despatch Oven Co., Minneapolis, Minn.
Drever Co., Philadelphia, Pa.
Eclipse Fuel Engineering Co., Rockford, Ill.
Electric Furnace Co., Salem, O.
M. K. Epstein Co., Springfield, Mass.
Falls Electric Furnace Corp., Buffalo
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago, Ill.
Hevi Duty Electric Co., Milwaukee, Wis.
A. F. Holden Co., New Haven, Conn.
Charles A. Hones, Inc., Baldwin, N. Y.
Hoskins Mfg. Co., Detroit, Mich.
Indus. Heating Equip. Co., Detroit, Mich.
Johnson Gas Appl. Co., Cedar Rapids, Iowa
Kali Mfg. Co., Philadelphia, Pa.
C. M. Kemp Mfg. Co., Baltimore, Md.
James H. Knapp Co., Los Angeles
Lansing Engineering Co., Lansing, Mich.
Lindberg Engineering Co., Chicago, Ill.
Mahr Manufacturing Co., Minneapolis
R-S Products Corp., Philadelphia, Pa.
Radiant Combustion, Inc., Warren, Ohio
W. S. Rockwell Co., New York
Sentry Co., Foxboro, Mass.
Standard Fuel Engineering Co., Detroit
Surface Combustion, Toledo, Ohio
H. O. Swoboda, Inc., New Brighton, Pa.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Upton Electric Furnace Div., Commerce Pattern Foundry & Mach. Co., Detroit
Vulcan Corp., Philadelphia
Lee Wilson Engrg. Co., Cleveland, Ohio

FURNACES—Tempering [239]
Ajax Electric Co., Inc., Philadelphia
American Car & Foundry Co., New York
American Electric Furnace Co., Boston
Amer. Gas Furnace Co., Elizabeth, N. J.
Bellis Heat Treating Co., Branford, Conn.
Carl-Mayer Corp., Cleveland, Ohio
Case Hardening Service Co., Cleveland
Chicago Flexible Shaft Co., Chicago, Ill.
Continental Industrial Engineers, Chicago
Delaware Tool Steel Corp., Wilmington, Del.
Dempsey Ind. Fur. Corp., Springfield, Mass.
Despatch Oven Co., Minneapolis, Minn.
Drever Co., Philadelphia
Eclipse Fuel Engineering Co., Rockford, Ill.
Electric Furnace Co., Salem, O.
M. K. Epstein Co., Springfield, Mass.
Falls Electric Furnace Corp., Buffalo
Flinn & Dreffein Co., Chicago, Ill.
Gas Machinery Co., Cleveland
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago, Ill.
C. I. Hayes, Inc., Providence, R. I.
Hevi Duty Electric Co., Milwaukee, Wis.
A. F. Holden Co., New Haven, Conn.
Charles A. Hones, Inc., Baldwin, N. Y.
Hoskins Mfg. Co., Detroit, Mich.
Indus. Heating Equip. Co., Detroit, Mich.
Industrial Oven Engrg. Co., Cleveland
Johnson Gas Appl. Co., Cedar Rapids, Iowa
James H. Knapp Co., Los Angeles
Lansing Engineering Co., Lansing, Mich.
Leeds & Northrup Co., Philadelphia, Pa.
Lepel High Freq. Labs., Inc., New York
Lindberg Engineering Co., Chicago, Ill.
Lithium Co., Newark, N. J.
Mahr Manufacturing Co., Minneapolis
Pereny Equipment Co., Columbus, Ohio
G. S. Peterson Co., Cleveland, Ohio
R-S Products Corp., Philadelphia, Pa.
W. S. Rockwell Co., New York
J. O. Ross Engineering Corp., N. Y. City
Salem Engineering Co., Salem, Ohio
Sentry Co., Foxboro, Mass.
Standard Fuel Engineering Co., Detroit
Surface Combustion, Toledo, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.
Upton Electric Furnace Div., Commerce Pattern Foundry & Mach. Co., Detroit
Vulcan Corp., Philadelphia
Westinghouse Electric & Mfg. Co., E. Pgh.
Lee Wilson Engrg. Co., Cleveland, Ohio
Young Brothers Co., Detroit

FURNACES—Tool & Die Hardening [240]
Acme Furnace Co., Chicago, Ill.
Ajax Electric Co., Inc., Philadelphia
American Electric Furnace Co., Boston
Amer. Gas Furnace Co., Elizabeth, N. J.
Bell & Gossett Co., Chicago, Ill.
Bellis Heat Treating Co., Branford, Conn.
Carl-Mayer Corp., Cleveland, Ohio
Case Hardening Service Co., Cleveland
Chicago Flexible Shaft Co., Chicago, Ill.
Cont. Industrial Engineers, Chicago
Delaware Tool Steel Corp., Wilmington, Del.
Dempsey Ind. Fur. Corp., Springfield, Mass.
Despatch Oven Co., Minneapolis, Minn.
Drever Co., Philadelphia
Eclipse Fuel Engineering Co., Rockford, Ill.
M. K. Epstein Co., Springfield, Mass.
Falls Electric Furn. Corp., Buffalo, N. Y.
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago, Ill.
C. I. Hayes, Inc., Providence, R. I.
Hevi Duty Electric Co., Milwaukee, Wis.
A. F. Holden Co., New Haven, Conn.
Charles A. Hones, Inc., Baldwin, N. Y.
Hoskins Mfg. Co., Detroit, Mich.
James H. Knapp Co., Los Angeles
Lansing Engineering Co., Lansing, Mich.
Leeds & Northrup Co., Philadelphia, Pa.
Lepel High Freq. Labs., Inc., New York
Lindberg Engineering Co., Chicago, Ill.
Lithium Co., Newark, N. J.
Mahr Manufacturing Co., Minneapolis
Morrison Engineering Co., Inc., Cleveland
Pereny Equipment Co., Columbus, O.
R-S Products Corp., Philadelphia
Radio Corp. of America—RCA Victor Div., Camden, N. J.
W. S. Rockwell Co., New York
Sellers Engineering Co., Chicago
Sentry Co., Foxboro, Mass.
Standard Fuel Engineering Co., Detroit
Surface Combustion, Toledo, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.
Upton Electric Furnace Div., Commerce Pattern Foundry & Mach. Co., Detroit
Vulcan Corp., Philadelphia
Lee Wilson Engrg. Co., Cleveland, Ohio

FURNACES—Tube Comb. Analy. [241]
Burrell Technical Supply Co., Pittsburgh
Case Hardening Service Co., Cleveland
Central Scientific Co., Chicago, Ill.
Harry W. Dietert Co., Detroit, Mich.
Drever Co., Philadelphia
Ecco High Frequency Corp., New York
Eimer & Amend, New York
M. K. Epstein Co., Springfield, Mass.
Fisher Scientific Co., Pittsburgh
Claud S. Gordon Co., Chicago, Ill.
Hevi Duty Electric Co., Milwaukee, Wis.
Hoskins Manufacturing Co., Detroit
Lindberg Engineering Co., Chicago
R-S Products Corp., Philadelphia, Pa.
W. S. Rockwell Co., New York
E. H. Sargent & Co., Chicago
Sentry Co., Foxboro, Mass.
Tate-Jones & Co., Inc., Leetsdale, Pa.

FURNACES—Wire, Annealing Galv. [242]
Ajax Electric Co., Inc., Philadelphia
American Electric Furnace Co., Boston
Am. Gas Furnace Co., Elizabeth, N. J.
Amsler-Morton Co., Pittsburgh, Pa.
Bellis Heat Treating Co., Branford, Conn.
Chicago Flexible Shaft Co., Chicago, Ill.
Continental Industrial Engineers, Chicago
Dempsey Ind. Fur. Corp., Springfield, Mass.
Despatch Oven Co., Minneapolis, Minn.
Drever Co., Philadelphia, Pa.
Eclipse Fuel Engineering Co., Rockford, Ill.
Electric Furnace Co., Salem, O.
M. K. Epstein Co., Springfield, Mass.
Flinn & Dreffein Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago, Ill.
A. F. Holden Co., New Haven, Conn.
C. M. Kemp Mfg. Co., Baltimore, Md.
Lepel High Freq. Labs., Inc., New York
Lithium Co., Newark, N. J.
Mahr Manufacturing Co., Minneapolis
Morrison Engineering Corp., Cleveland
R-S Products Corp., Philadelphia, Pa.
W. S. Rockwell Co., New York
Salem Engineering Co., Salem, Ohio
Surface Combustion, Toledo, Ohio
Swindell-Dressler Corp., Pittsburgh, Pa.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Upton Electric Furnace Div., Commerce Pattern Foundry & Mach. Co., Detroit
Vulcan Corp., Philadelphia
Westinghouse Elec. & Mfg. Co., E. Pgh.
Lee Wilson Engrg. Co., Cleveland, Ohio

GAGES [243]
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia
Beals-McCarthy & Rogers, Inc., Buffalo
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Brush Development Co., Cleveland, Ohio
Cinaudagraph Corp., Stamford, Conn.
Coates Machine Tool Co., Scarsdale, N. Y.
Continental Machine, Inc., Minneapolis
Detroit Tap & Tool Co., Detroit
Engineers Specialties Div., Cleveland
Engineers Specialties Div., Buffalo
Federal Products Corp., Providence, R. I.
Firth-Sterling Steel Co., McKeesport, Pa.
Foxboro Co., Foxboro, Mass.
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago, Ill.
Hays Corp., Michigan City, Ind.
Lincoln Park Tool & Gage Co., Lincoln Park, Mich.
Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Master Tool Co., Inc., Cleveland
Physicists Research Co., Ann Arbor, Mich.
Protective Coatings, Inc., Detroit
Riehle Testing Machine Div.; American Machine & Metals, Inc., East Moline, Ill.
George Scherr Co., New York, N. Y.
Sheffield Corp., Dayton, Ohio
Size Control Co., Chicago
L. S. Starrett Co., Athol, Mass.
F. J. Stokes Machine, Philadelphia, Pa.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Wheelco Instruments Co., Chicago, Ill.
Willey's Carbide Tool Co., Detroit
Carl Zeiss, Inc., New York

GAGES, DIAL INDICATORS [244]
Anderson & Sons, Westfield, Mass.
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia, Pa.
Bell & Gossett Co., Morton Grove, Ill.
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Federal Products Corp., Providence, R. I.
Foxboro Co., Foxboro, Mass.
Claud S. Gordon Co., Chicago, Ill.
Jones Motrola Sales Co., Stamford, Conn.
Pyrometer Instrument Co., New York City
Riehle Testing Machine Div.; American Machine & Metals, Inc., East Moline, Ill.
George Scherr Co., New York, N. Y.
Size Control Co., Chicago
L. S. Starrett Co., Athol, Mass.
Testing Machines, Inc., New York
Wheelco Instruments Co., Chicago, Ill.
Carl Zeiss, Inc., New York

GALVANIZED SHEETS [245]
American Steel & Wire, Cleveland, Ohio
Apollo Metals Works, Chicago
Apollo Steel Co., Apollo, Pa.
Beals-McCarthy & Rogers, Inc., Buffalo
Bethlehem Steel Co., Bethlehem, Pa.
Carnegie-Illinois Steel Corp., Pittsburgh
Columbia Steel Co., San Francisco, Calif.
Continental Steel Corp., Kokomo, Ind.
Granite City Steel Co., Granite City, Ill.
Inland Steel Co., Chicago
Horace T. Potts Co., Philadelphia, Pa.
Republic Steel Corp., Cleveland
Jos. T. Ryerson & Son, Inc., Chicago
Tenn. Coal, Iron & R. R. Co., Birm., Ala.
U. S. Steel Supply Co., Chicago

GALVANIZING [246]
Acme Galvanizing, Inc., Milwaukee, Wis.
Acme Steel & Mall. Iron Wks., Buffalo
American Bridge Co., Pittsburgh, Pa.
American Hot Dip Galv. Assn., Pittsburgh
American Tinning & Galv. Co., Erie, Pa.
Atlantic Stamping Co., Rochester, N. Y.
Atlantic Steel Co., Atlanta, Ga.
Bethlehem Steel Co., Bethlehem, Pa.
Buffalo Galv. & Tinning Wks., Buffalo

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ffalo Wire Works Co., Buffalo
icago Flexible Shaft Co., Chicago, Ill.
mmercial Metals Treating, Inc., Toledo
mond Exp. Bolt Co., Garwood, N. J.
sco Derrick & Equip. Co., Los Angeles
up. Steel Prod. Div., Union Asbestos
nd Rubber Co., Blue Island, Ill.
ner Mfg. Co., Cleveland
n Finn Metal Works, San Francisco
lvanizers, Portland, Oregon
omas Gregory Galvanizing Works, Maspeth, N. Y.
lon-Gregory Galv. Co., Pittsburgh
nes Hill Mfg. Co., Providence, R. I.
bbard & Co., Oakland, Calif.
dependent Galv. Co., Newark, N. J.
ternational-Stacey Corp., Columbus, O.
uson Iron Works, Seattle, Wash.
lyn Co. of California, Los Angeles
lyn Mfg. & Supply Co., Chicago, Ill.
O Koven & Brother, Jersey City, N. J.
omas Laughlin Co., Portland, Maine
lish Struct'l Steel Co., Allentown, Pa.
ers Bolt & Nut Co., Minneapolis, Minn.
s Angeles Galvanizing Co., Huntington Park, Calif.
eker Co., Chicago, Ill.
ssouri Roll'g Mill Corp., St. Louis, Mo.
tional Telephone Supply Co., Cleveland
ver Iron & Steel Corp., Pittsburgh
en Galvanizing Co., Philadelphia, Pa.
epublic Steel Corp., Cleveland, Ohio
verside Fdry & Galv. Co., Kalamazoo
n Francisco Galv. Wks., San Francisco
nitary Tinning Co., Cleveland
outhern Galvanizing Co., Baltimore
tandard Galvanizing Co., Chicago
ean Engineering Co., Inc., Warren, O.
estinghouse Electric & Mfg. Co., E. Pgh.
Wm. Crittenden & Co., Inc., Middletown, Conn.
ut Cornice Co., Cincinnati, O.

AS ANALYSIS RECORDERS [247]
rown Instrument Co., Philadelphia, Pa.
mbridge Instrument Co., Inc., N. Y., N. Y.
harles Englehard, Inc., Newark, N. J.
ys Corp., Michigan City, Ind.
ees & Northrup Co., Philadelphia, Pa.
ine Safety Appliances Co., Pgh., Pa.

AS—Boosters & Exhausters [248]
is-Chalmers Mfg. Co., Milwaukee, Wis.
ner. Gas Furnace Co., Elizabeth, N. J.
each Russ Co., New York
alite Tungsten Corp., Union City, N. J.
clipse Fuel Engineering Co., Rockford, Ill.
ersoll-Rand Co., New York
M Kemp Mfg. Co., Baltimore, Md.
rl Machine Works, Chicago
ermutit Co., New York
outs-Connersville Blower Corp., Connersville, Ind.
pencer Turbine Co., Hartford, Conn.
ulcan Corp., Philadelphia

AS BURNERS—See Burners—Gas

AS PRODUCERS [249]
ner. Gasifier Co., Wallingford, Conn.
n. Gas Furnace Co., Elizabeth, N. J.
msler-Morton Co., Pittsburgh
ntinental Industrial Engineers, Chicago
ectric Arc, Inc., Newark, N. J.
ectric Furnace Co., Salem, Ohio
linn & Dreffein Co., Chicago, Ill.
eneral Electric, Schenectady, N. Y.
rdler Corp., Gas Processes Div., Louisville
ri Duty Electric Co., Milwaukee
M Kemp Mfg. Co., Baltimore, Md.
ppers Co., Philadelphia
e Wilson Engrg. Co., Cleveland, Ohio

ASKETS—Asbestos, Cork [250]
etroit Gasket & Mfg. Co., Detroit
ohns-Manville, New York
easley & Mattison Co., Ambler, Pa.
anhattan Rubber Mfg. Div. of Raybestos-Manhattan, Inc., Passaic, N. J.

ENERATORS—Acetylene [251]
r Reduction, New York
arris Calorific Co., Cleveland, Ohio
nde Air Products Co., New York
arquette Mfg. Co., Inc., Minneapolis
odern Engineering Co., St. Louis, Mo.
ational Cylinder Gas Co., Chicago, Ill.
ght Feed Generator Co., Richmond, Ind.
mith Welding Equipment Corp., Minneapolis, Minn.
niversal Power Corp., Cleveland

ENERATORS—Nitrogen [252]
ax Metal Co., Philadelphia
ntinental Industrial Engineers, Chicago
Electric Furnace Co., Salem, Ohio
Mahr Manufacturing Co., Minneapolis
Surface Combustion, Toledo, Ohio

GENERATORS—Plating [253]
Columbia Electric & Mfg. Co., Cleveland
Crown Rheostat & Supply Co., Chicago
General Electric Co., Schenectady, N. Y.
Hanson-Van Winkle-Munning Co., Matawan, N. J.
Hobart Brothers Co., Troy, Ohio
Ideal Electric & Mfg. Co., Mansfield, O.
Chas. F. L'Hommedieu Sons & Co., Chicago
MacDermid, Inc., Waterbury, Conn.
Harold E. Trent Co., Philadelphia, Pa.
U. S. Galvanizing & Plating Equipment Corp., Brooklyn, N. Y.
Westinghouse Electric & Mfg. Co., E. Pgh.

GENERATORS—Special Atmosphere [254]
Ajax Electric Co., Inc., Philadelphia
Ajax Metal Co., Philadelphia
Amer. Electric Furnace Co., Boston
Amer. Gas Furnace Co., Elizabeth, N. J.
Case Hardening Service Co., Cleveland
Continental Industrial Engineers, Chicago
Electric Furnace Co., Salem, O.
Flinn & Dreffein Co., Chicago, Ill.
Gas Machinery Co., Cleveland
General Electric Co., Schenectady, N. Y.
C. I. Hayes, Inc., Providence, R. I.
Holcroft & Co., Detroit
Lindberg Engineering Co., Chicago, Ill.
Mahr Manufacturing Co., Minneapolis
Salem Engineering Co., Salem, Ohio
Sargent & Wilbur, Pawtucket, R. I.
Surface Combustion, Toledo, Ohio
Lee Wilson Engrg. Co., Cleveland, Ohio

GOLD & GOLD ALLOYS [255]
Thomas J. Dee & Co., Chicago
Handy & Harman, New York
J. M. Ney Co., Hartford, Conn.

GRAPHITE [256]
International Graphite & Electrode Corp., St. Marys, Pa.
National Carbon Co., Inc., Cleveland
National Carbon Co., Inc., New York

GREASE—See Lubricants

GRINDING AND POLISHING MACHINES [257]
American Opt. Co., Southbridge, Mass.
Adolph I. Buehler, Chicago, Ill.
Cincinnati Elec. Tool Co., Cincinnati, O.
Divine Brothers Co., Utica, N. Y.
Eberbach & Son Co., Ann Arbor, Mich.
Hammond Machy. Bldrs., Kalamazoo, Mich.
Howe & Son, Inc., Hinsdale, N. H.
Independent Pneumatic Tool Co., Chicago
Ingersoll-Rand Co., New York
Landis Tool Co., Waynesboro, Pa.
MacDermid, Inc., Waterbury, Conn.
Manderscheid Co., Chicago
Norton Co., Worcester, Mass.
Porter-Cable Machine Co., Syracuse, N. Y.
Precision Scientific Co., Chicago
Production Machine Co., Greenfield, Mass.
Thomas Prosser & Son, New York
Jos. T. Ryerson & Son, Inc., Chicago
George Scherr Co., Inc., New York
Sturgis Prod. Co., Sturgis, Mich.
Vonnegut Moulder Corp., Indianapolis
Wicaco Machine Corp., Phil., Pa.

GRINDING MACHINES—Portable Electric [258]
Black & Decker Mfg. Co., Towson, Md.
Chicago Wheel & Mfg. Co., Chicago, Ill.
Hammond Machinery Builders, Inc., Kalamazoo, Mich.
Independent Pneumatic Tool Co., Chicago
Ingersoll-Rand Co., Phillipsburg, N. J.
MacDermid, Inc., Waterbury, Conn.
Mall Tool Co., Chicago
Millers Falls Co., Greenfield, Mass.
Porter-Cable Machine Co., Syracuse, N. Y.
Thomas Prosser & Son, New York
Rotor Tool Co., Cleveland
Jos. T. Rverson & Son, Inc., Chicago
Skilsaw, Inc., Chicago
Stanley Elec. Tool Div., Stanley Works, New Britain, Conn.
Stoody Co., Whittier, Cal.
Stow Mfg. Co., Binghamton, N. Y.

GRINDING MACHINES—Surface [259]
Abrasive Mach. Tool Co., E. Providence, R.I.
Arter Grinding Mach. Co., Worcester, Mass.
Continental Machines, Inc., Minneapolis
Hammond Machinery Builders, Inc., Kalamazoo, Mich.
Hill-Acme Co., Cleveland
H. Leach Mach. Co., Providence, R. I.
MacDermid, Inc., Waterbury, Conn.
Norton Co., Worcester, Mass.
Porter-Cable Mach. Co., Syracuse, N. Y.
Thomas Prosser & Son, New York
Jos. T. Ryerson & Son, Inc., Chicago
Taft-Peirce Mfg. Co., Woonsocket, R. I.

GRINDING WHEELS [260]
Abrasive Co., Philadelphia
Amer. Emery Wheel Wks., Providence, R.I.
Carborundum Co., Niagara Falls, N. Y.
Chicago Wheel & Mfg. Co., Chicago, Ill.
Cincinnati Elec. Tool Co., Cincinnati, O.
A. P. DeSanno & Son, Phoenixville, Pa.
Divine Brothers Co., Utica, N. Y.
Electro Ref. & Alloys Corp., Buffalo
W. J. Holliday & Co., Hammond, Ind.
K. O. Lee Co., Aberdeen, S. D.
MacDermid, Inc., Waterbury, Conn.
Macklin Co., Jackson, Mich.
Manhattan Rubber Mfg. Div., Raybestos-Manhattan, Inc., Passaic, N. J.
Norton Co., Worcester, Mass.
Thomas Prosser & Son, New York
Size Control Co., Chicago
Sterling Grinding Wheel Div., Tiffin, O.
West Co., Inc., Philadelphia, Pa.

GRIT—Steel—See Abrasives

HACK SAW BLADES—See Saws

HAMMERS—Board Drop [261]
Billings & Spencer Co., Hartford, Conn.
Chambersburg Eng. Co., Chambersb'g, Pa.
Erie Foundry Co., Erie, Pa.
Moslo Machinery Co., Cleveland
Standard Machinery Co., Providence, R. I.

HAMMERS—Steam Drop [262]
Chambersburg Eng. Co., Chambersb'g, Pa.
Erie Foundry Co., Erie, Pa.
Ladish Drop Forge Co., Cudahy, Wisc.

HARDNESS TESTERS [263]
Barber-Colman Co., Rockford, Ill.
Bausch & Lomb Opt. Co., Rochester, N. Y.
Adolph I. Buehler, Chicago, Ill.
Burrell Technical Supply Co., Pittsburgh
Case Hardening Service Co., Cleveland
Central Scientific Co., Chicago, Ill.
Eberbach & Son Co., Ann Arbor, Mich.
R. Y. Ferner Co., Boston, Mass.
Claud S. Gordon Co., Chicago, Ill.
Andrew King, Narberth, Pa.
Tinius Olsen Testing Machine Co., Phila.
Pittsburgh Instrument & Machine Co., Pittsburgh, Pa.
Riehle Testing Machine Div.; American Machine & Metals, Inc., East Moline, Ill.
E. H. Sargent & Co., Chicago
Size Control Co., Chicago
Spencer Lens Co., Buffalo, N. Y.
Steel City Testing Lab., Detroit, Mich.
Teleweld, Inc., Chicago
Wilson Mech. Instrument Co., New York

HEARTHS—Refractory [264]
Amer. Gas Furnace Co., Elizabeth, N. J.
Carborundum Co., Perth Amboy, N. J.
Eclipse Fuel Eng. Co., Rockford, Ill.
Electro Ref. & Alloys Corp., Buffalo
General Refractories Co., Philadelphia
Johns-Manville, New York, N. Y.
Laclede-Christy Clay Prod. Co., St. Louis
Lava Crucible Co. of Pittsburgh
National Carbon Co., Inc., New York
Norton Co., Worcester, Mass.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Chas. Taylor Sons Co., Cincinnati, Ohio

HEAT EXCHANGERS [265]
Amer. Locomotive Co., Schenectady, N. Y.
Amsler-Morton Co., Pittsburgh, Pa.
Babcock & Wilcox Co., New York
Bell & Gossett Co., Chicago, Ill.
Binks Mfg. Co., Chicago, Ill.
Brown Fintube Co., Elyria, Ohio
Carl-Mayer Corp., Cleveland, Ohio
Case Hardening Service Co., Cleveland
Chicago Flexible Shaft Co., Chicago
Continental Industrial Engineers, Chicago
Corning Glass Works, Corning, N. Y.
Duriron Co., Inc., Dayton, O.
Elematic Sales Corp., Blue Island, Ill.
Griscom-Russell Co., New York
Heil Engineering Co., Cleveland
Ingersoll-Rand Co., New York
M. W. Kellogg Co., Jersey City, N. J.
McCann Furnace Co., Cleveland, Ohio
Morrison Engineering Corp., Cleveland
National Carbon Co., Inc., Cleveland
National Carbon Co., Inc., New York
Niagara Blower Co., New York
Patterson-Kelley Co., E. Stroudsburg, Pa.
J. O. Ross Engineering Corp., N. Y. City
Ross Heater & Mfg Co., Inc., Buffalo, N. Y.
Sims Co., Erie, Pa.

Sweden Freezer Mfg. Co., Seattle, Wash.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia
Whitlock Mfg. Co., Hartford, Conn.

HEAT REMOVERS [266]
Brown Fintube Co., Elyria, Ohio
Niagara Blower Co., New York
Sims Co., Erie, Pa.
Sweden Freezer Mfg. Co., Seattle, Wash.
Tate-Jones & Co., Inc., Leetsdale, Pa.

HEAT TREATING [267]
Amer. Gas Furnace Co., Elizabeth, N. J.
Amer. Metal Treat. Co., Elizabeth, N. J.
Amer. Shear Knife Co., Homestead, Pa.
Associated Spring Corp.—Wallace Barnes Co. Div., Bristol, Conn.
Bellis Heat Treating Co., Branford, Conn.
Budd Induction Heating, Inc., Detroit
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Chicago Flexible Shaft Co., Chicago
Cinaudagraph Corp., Stamford, Conn.
Commercial Steel Treating Corp., Detroit
Commonwealth Industries, Detroit
Drever Co., Philadelphia, Pa.
E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Eastern Heat Treating & Brazing Corp., New York
Eclipse Fuel Engrg. Co., Rockford, Ill.
Federal Tel. & Radio Corp., Newark, N. J.
Follansbee Steel Corp., Pittsburgh, Pa.
Foster Steel Treating Co., Newark, N. J.
Fostoria Pressed Steel Co., Fostoria, O.
General Electric Co., Schenectady, N. Y.
Gunite Foundries Corp., Rockford, Ill.
Heatbath Corporation, Springfield, Mass.
Heinzelman's Heat Treating Hardening Works, Inc., New York
Hevi Duty Electric Co., Milwaukee, Wis.
A. F. Holden Co., West Haven, Conn.
E. F. Houghton & Co., Philadelphia, Pa.
C. M. Kemp Mfg. Co., Baltimore, Md.
James H. Knapp Co., Los Angeles
Lakeside Steel Improvem't Co., Cleveland
Leeds & Northrup Co., Philadelphia, Pa.
Lepel High Freq. Labs., Inc., New York
Lindberg Steel Treating Co., Chicago, Ill.
Linde Air Products Co., New York
Lorenz & Son, Inc., Philadelphia
Massachusetts Steel Treating Corp., Worcester, Mass.
Metlab Co., Philadelphia, Pa.
Midvale Co., Philadelphia
Morrison Engineering Co., Cleveland
New England Metallurgical Corp., Boston
Ohio Crankshaft Co., Cleveland
Perfection Tool & Metal Heat Treating Co., Chicago, Ill.
Pittsburgh Com. Heat Treat. Co., Pgh.
Porter Forge & Furn. Inc., Everett, Mass.
Queen City Steel Treating Co., Cincinnati
Radiant Combustion, Inc., Warren, Ohio
Rhode Island Tool Co., Providence, R. I.
J. O. Ross Engineering Corp., New York
C. U. Scott & Son, Rock Island, Ill.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Thurner Heat Treat. Co., Milwaukee, Wis.
Upton Elec. Salt Bath Fur. Co., Detroit
Vulcan Corp., Philadelphia
Warren Tool Corp., Warren, O.
Wesley Steel Treating Co., Milwaukee
Westinghouse Elec. & Mfg. Co., E. Pgh.
Wiedemann Machine Co., Philadelphia, Pa.

HEAT TREATING BELTS, TRAYS [268]
Alloy Casting Co., Champaign, Ill.
Amer. Mang. Steel Div., Amer. Brake Shoe Co., Chicago Hts., Ill.
Audubon Wire Cloth Corp., Philadelphia
Calorizing Co., Wilkinsburg, Pgh., Pa.
Carborundum Co., Niagara Falls, N. Y.
Chicago Steel Foundry Co., Chicago, Ill.
Driver-Harris Co., Harrison, N. J.
Duraloy Co., Scottdale, Pa.
Electro Alloys Co., Elyria, Ohio
Fahralloy Co., Harvey, Ill.
General Alloys Co., Boston, Mass.
Hoskins Mfg. Co., Detroit, Mich.
Michigan Steel Casting Co., Detroit, Mich.
Ohio Steel Foundry Co., Springfield, Ohio
Rolock, Inc., Fairfield, Conn.
Standard Alloy Co., Cleveland
Sterling Alloys, Inc., Woburn, Mass.
Surface Combustion, Toledo, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia

HEAT TREATING CONTAINERS [269]
Alloy Casting Co., Champaign, Ill.
Amer. Mang. Steel Div., Chicago Hts., Ill.
Bell & Gossett Co., Chicago, Ill.
Case Hardening Service Co., Cleveland
Calorizing Co., Wilkinsburg, Pgh., Pa.
Chicago Steel Foundry Co., Chicago, Ill.
Driver-Harris Co., Harrison, N. J.
Duraloy Co., Scottdale, Pa.
Eclipse Fuel Engrg. Co., Rockford, Ill.
Electro Alloys Co., Elyria, Ohio
Fahralloy Co., Harvey, Ill.
General Alloys Co., Boston, Mass.
Hevi Duty Electric Co., Milwaukee, Wis.
Hoskins Mfg. Co., Detroit, Mich.
Lebanon Steel Foundry, Lebanon, Pa.
Ludlow-Saylor Wire Co., St. Louis
Mahr Mfg. Co., Minneapolis, Minn.
Michiana Prod. Corp., Michigan City, Ind.
Michigan Steel Casting Co., Detroit, Mich.
Ohio Steel Foundry Co., Springfield, O.
Pressed Steel Co., Wilkes-Barre, Pa.
Rolock, Inc., Fairfield, Conn.
Standard Alloy Co., Cleveland
Stanwood Corp., Chicago
Sterling Alloys, Inc., Woburn, Mass.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia

HEAT TREATING MATERIALS [270]
Amer. Cyan. & Chem. Corp., New York
Am. Gas Furnace Co., Elizabeth, N. J.
Armour Ammonia Works, Chicago, Ill.
Bell & Gossett Co., Chicago, Ill.
Brickseal Refractory Corp., Hoboken, N. J.
Case Hardening Service Co., Cleveland
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Char Products Co., Indianapolis, Ind.
Chicago Steel Foundry Co., Chicago, Ill.
Driver-Harris Co., Harrison, N. J.
E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.
Ecco Chemical Corp., Union City, N. J.
Eclipse Fuel Engrg. Co., Rockford, Ill.
Electric Furnace Co., Salem, Ohio
Foote Mineral Co., Philadelphia
General Alloys Co., Boston, Mass.
Claud S. Gordon Co., Chicago, Ill.
Heatbath Corp., Springfield, Mass.
A. F. Holden Co., West Haven, Conn.
E. F. Houghton & Co., Philadelphia, Pa.
Kali Mfg. Co., Philadelphia, Pa.
Kasenit Co., New York, N. Y.
J. W. Kelley Co., Cleveland, Ohio
Mathieson Alkali Works, New York
Mitchell-Bradford Chem. Co., Bridgeport, Conn.
Park Chemical Co., Detroit, Mich.
Rodman Chemical Co., Verona, Pa.
G. S. Rogers & Co., Chicago, Ill.
Steel Treating Equipment Co., Detroit
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia
Warren Ref. & Chem. Co., Cleveland

HEATERS—Gas [271]
American Gas Assn., New York, N. Y.
Brown Fintube Co., Elyria, Ohio
Carl-Mayer Corp., Cleveland, Ohio
Continental Industrial Engineers, Chicago
Despatch Oven Co., Minneapolis, Minn.
Eclipse Fuel Engrg. Co., Rockford, Ill.
F. J. Fieser Co., New York
Forest City Foundries Co., Cleveland, O.
E. A. Furkert Co., Chicago
Claud S. Gordon Co., Chicago, Ill.
Charles A. Hones, Inc., Baldwin, N. Y.
Industrial Gas Engineering Co., Chicago
Johnson Gas Appl. Co., Cedar Rapids, Ia.
Lanly Co., Cleveland
Paul Maehler Co., Chicago
McCann Furnace Co., Cleveland, Ohio
Morrison Engineering Corp., Cleveland
National Machine Works, Chicago
Radiant Combustion, Inc., Warren, Ohio
J. O. Ross Engineering Corp., N. Y. City
Salem Engineering Co., Salem, O.
Selas Co., Philadelphia, Pa.
Submerged Comb. Co. of Amer., New York
Surface Combustion, Toledo, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia
Young Brothers Co., Detroit

HEATERS—Oil [272]
Brown Fintube Co., Elyria, Ohio
Carl-Mayer Corp., Cleveland, Ohio
Continental Industrial Engineers, Chicago
Despatch Oven Co., Minneapolis, Minn.
Globe Mach. & Stamping Co., Cleveland
Claud S. Gordon Co., Chicago, Ill.
Griscom-Russell Co., New York
Hauck Manufact'g Co., Brooklyn, N. Y.
Industrial Gas Engineering Co., Chicago
Mahr Manufacturing Co., Minneapolis
McCann Furnace Co., Cleveland, Ohio
Morrison Engineering Corp., Cleveland
National Radiator Co., Johnstown, Pa.
J. O. Ross Engineering Corp., New York
Ross Heater & Mfg Co., Inc., Buffalo, N.
Salem Engineering Co., Salem, O.
Sims Co., Erie, Pa.
Surface Combustion, Toledo, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia
Young Brothers Co., Detroit

HEATERS—Unit [273]
American Blower Corp., Detroit
Amer. F'dry Equipment Co., Mishawaka
Amer. Gas Assn., New York, N. Y.
Amer. Instrument Co., Silver Spring, Md.
Buffalo Forge Co., Buffalo, N. Y.
Carborundum Co., Niagara Falls, N.
Carl-Mayer Corp., Cleveland, Ohio
Continental Industrial Engineers, Chicago
Fedders Mfg. Co., Buffalo
General Electric Co., Schenectady, N.
Morrison Engineering Corp., Cleveland
National Carbon Co., Inc., New York
National Radiator Co., Johnstown, Pa.
Niagara Blower Co., New York
Radiant Combustion, Inc., Warren, Ohio
J. O. Ross Engineering Corp., N. Y. City
Salem Engineering Co., Salem, O.
B. F. Sturtevant Co., Boston, Mass.
Surface Combustion, Toledo, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.
Westinghouse Elec. & Mfg. Co., E. Pgh.
Edwin L. Wiegand Co., Pittsburgh, Pa.

HEATING ELEMENTS—High Temperature Electric [274]
Alloy Casting Co., Champaign, Ill.
Amer. F'dry Equip. Co., Mishawaka, Ind.
Amer. Mang. Steel Div., American Brake Shoe Co., Chicago Hts.
Budd Induction Heating, Inc., Detroit
Burrell Technical Supply Co., Pittsburgh
Carborundum Co., Niagara Falls, N. Y.
Continental Industrial Engineers, Chicago
Driver-Harris Co., Harrison, N. J.
Wilbur B. Driver Co., Newark, N. J.
Electric Furnace Co., Salem, Ohio
Electro Alloys Co., Elyria, Ohio
General Alloys Co., Boston, Mass.
General Electric Co., Schenectady, N.
Claud S. Gordon Co., Chicago, Ill.
Hevi Duty Electric Co., Milwaukee, Wis.
A. F. Holden Co., West Haven, Conn.
Hoskins Mfg. Co., Detroit, Mich.
Lindberg Engineering Co., Chicago, Ill.
Ohio Steel Foundry Co., Springfield, O.
Sterling Alloys, Inc., Woburn, Mass.
B. F. Sturtevant Co., Boston, Mass.
Harold E. Trent Co., Philadelphia, Pa.
Vulcan Corp., Philadelphia
Westinghouse Elec. & Mfg. Co., E. Pgh.

HEATING ELEMENTS—Radiant T [275]
Alloy Casting Co., Champaign, Ill.
Alloy Mfg. Co., Pittsburgh, Pa.
Callite Tungsten Corp., Union City, N.
Calorizing Co., Pittsburgh, Pa.
Carborundum Co., Niagara Falls, N.
Continental Industrial Engineers, Chi
Despatch Oven Co., Minneapolis, Minn.
Driver-Harris Co., Harrison, N. J.
Wilbur B. Driver Co., Nevark, N. J.
Duraloy Co., Scottdale, Pa.
Electric Furnace Co., Salem, Ohio
Electro-Alloys Co., Elyria, O.
Flinn & Dreffein Co., Chicago, Ill.
Gas Machinery Co., Cleveland
General Alloys Co., Boston, Mass.
C. M. Kemp Mfg. Co., Baltimore, Md.
Michigan Steel Casting Co., Detroit, M
Pressed Steel Co., Wilkes-Barre, Pa.
Sterling Alloys, Inc., Woburn, Mass.
Surface Combustion, Toledo, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.
Harold E. Trent Co., Philadelphia, Pa.
Vulcan Corp., Philadelphia
Lee Wilson Companies, Cleveland, Ohi

HELMETS—Welders [276]
Allied Weld-craft, Inc., Indianapolis, I
Amer. Optical Co., Southbridge, Mass.
Arcos Corp., Philadelphia, Pa.
Brown-Wales Co., Boston, Mass.
Chicago Eye Shield Co., Chicago, Ill.
Davis Emergency Equip. Co., Newark, N.
Dockson Corp., Detroit, Mich.
General Electric Co., Schenectady, N.

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Lincoln Electric Co., Cleveland, Ohio
Marquette Mfg. Co., Inc., Minneapolis
Mine Safety Appliances Co., Pittsburgh
National Cylinder Gas Co., Chicago
Horace T. Potts Co., Philadelphia, Pa.
Sellstrom Mfg. Co., Chicago, Ill.
U. S. Steel Supply Co., Chicago
Universal Power Corp., Cleveland
Welding Engineering Co., Milwaukee, Wis.
Westinghouse Elec. & Mfg. Co., E. Pgh., Pa.
Whitehead Metal Products Co., New York
Willson Products, Inc., Reading, Pa.

HOISTS—Mechanical or Pneumatic [277]
C. O. Bartlett & Snow Co., Cleveland
Beals-McCarthy & Rogers, Inc., Buffalo
Brown-Wales Co., Boston, Mass.
Cleve. Crane & Engr. Co., Wickliffe, O.
Clipper Manufacturing Co., St. Louis, Mo.
Coffing Hoist Co., Danville, Ill.
Conco Engineering Works, Mendota, Ill.
Electro Lift, Inc., New York City
Ford Chain Block Div., American Chain & Cable, Philadelphia, Pa.
Harrington Co., Philadelphia, Pa.
Independent Pneumatic Tool Co., Chicago
Ingersoll-Rand Co., New York
Jeffrey Mfg. Co., Columbus, Ohio
Lyon-Raymond Corp., Greene, N. Y.
MacDermid, Inc., Waterbury, Conn.
Mahr Mfg. Co., Minneapolis, Minn.
Manning, Maxwell & Moore, Inc., Muskegon, Mich.
Mathews Conveyor Co., Ellwood City, Pa.
Parsons Engineering Corp., Cleveland
Robins Conveyors, Inc., Passaic, N. J.
Scully Steel Products Co., Chicago, Ill.
Stephens-Adamson Mfg. Co., Aurora, Ill.
Willamette Hyster Co., Portland, Oregon
Wright Mfg. Div., York, Pa.
Yale & Towne Mfg. Co., Philadelphia, Pa.

HOT SAWING, BUR'G MACH. [278]
Ajax Mfg. Co., Cleveland, Ohio

HYDRAULIC MACHINERY [279]
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia, Pa.
Bethlehem Steel Co., Bethlehem, Pa.
Chambersburg Eng. Co., Chambersb'g, Pa.
Elmes Engineering Works of American Steel Foundries, Chicago
Hydropress, Inc., New York
Ingersoll-Rand Co., New York
Kux Machine Co., Chicago
Lake Erie Engineering Corp., Buffalo
Lyon-Raymond Corp., Greene, N. Y.
Pines Engineering Co., Aurora, Ill.

HYDRAULIC PRESSES—See Presses

INDICATORS [280]
Amer. Gas Furnace Co., Elizabeth, N. J.
Anderson & Sons, Westfield, Mass.
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia, Pa.
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Davis Emergency Equip. Co., Newark, N. J.
Foxboro Co., Foxboro, Mass.
Claud S. Gordon Co., Chicago, Ill.
Hays Corp., Michigan City, Ind.
Jones Motrola Sales Co., Stamford, Conn.
Leeds & Northrup Co., Philadelphia, Pa.
Mine Safety Appliance Co., Pittsburgh
Pyrometer Instrument Co., New York
George Scherr Co., New York, N. Y.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Wheelco Instruments Co., Chicago, Ill.

INDICATORS—Precision Measuring [281]
Anderson & Sons, Westfield, Mass.
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia, Pa.
Beals-McCarthy & Rogers, Inc., Buffalo
Brown Instrument Co., Philadelphia, Pa.
Cambridge Instrument Co., Inc., N. Y., N. Y.
W. C. Dillon & Co., Inc., Chicago
Dravo Corp., Pittsburgh
General Electric Co., Schenectady, N. Y.
Leeds & Northrup Co., Philadelphia, Pa.
Tinius Olsen Testing Mach. Co., Phila.
Pfaltz & Bauer, Inc., New York
Pyrometer Instrument Co., New York
Arklay S. Richards Co., Newton Highlands, Mass.
Riehle Testing Machine Div.; American Machine & Metals, Inc., East Moline, Ill.
George Scherr Co., Inc., New York
Sheffield Corp., Dayton, Ohio
Size Control Co., Chicago
L. S. Starrett Co., Athol, Mass.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Testing Machines, Inc., New York
Wheelco Instruments Co., Chicago, Ill.
Carl Zeiss, Inc., New York

INDICATORS—Sight Flow [282]
Amer. Gas Furnace Co., Elizabeth, N. J.
S. F. Bowser & Co., Inc., Ft. Wayne, Ind.
Brown Instrument Co., Philadelphia, Pa.
Fischer & Porter Co., Hatboro, Pa.
E. A. Furkert Co., Chicago
Selas Co., Philadelphia, Pa.
Tate-Jones & Co., Inc., Leetsdale, Pa.

INDIUM [283]
Amer. Smelting & Refining Co., N. Y.
Indium Corp. of America, New York

INDUCTION HEATING MACH. [284]
Ajax Electrothermic Corp., Trenton, N. J.
Budd Induction Heating, Inc., Detroit
Ecco High Frequency Corp., New York
Federal Tel. & Radio Corp., Newark, N. J.
General Electric Co., Schenectady, N. Y.
Induction Heating Corp., New York
Lepel High Freq. Labs., Inc., New York
North American Philips Co., New York
Ohio Crankshaft Co., Cleveland, Ohio
Radio Corp. of America—RCA Victor Div., Camden, N. J.
Stewart Furnace Div. of Chicago Flexible Shaft Co., Chicago, Ill.
Universal Power Corp., Cleveland
Westinghouse Elec. & Mfg. Co., E. Pgh.

INERT GAS MACHINES [285]
Continental Industrial Engineers, Chicago
Gas Machinery Co., Cleveland
Holcroft & Co., Detroit
C. M. Kemp Mfg. Co., Baltimore, Md.
Mahr Manufacturing Co., Minneapolis
Roots-Connersville Blower Corp., Connersville, Ind.
Surface Combustion, Toledo, Ohio
Lee Wilson Sales Corp., Cleveland

INGOT MOLDS [286]
Acme Foundry Co., Detroit
Bethlehem Steel Co., Bethlehem, Pa.
Gathmann Engineering Co., Baltimore
Meehanite Research Institute, Pgh., Pa.
Western Foundry Co., Chicago, Ill.

INGOTS—Non-Ferrous [287]
Ajax Metal Co., Philadelphia
Aluminum Co. of America, Pgh., Pa.
American Brass Co., Waterbury, Conn.
Bohn Aluminum & Brass Corp., Detroit
Carpenter Steel Co., Reading, Pa.
Duquesne Smelting Corp., Pittsburgh
Lumen Bearing Co., Buffalo, N. Y.
Metallurgical Products Co., Philadelphia
Nat'l Bronze & Alum. F'dry Co., Cleveland
Niagara Falls Smelting & Refining Corp., Buffalo, N. Y.
Revere Copper & Brass, Inc., New York
Reynolds Metals Co., Louisville, Ky.
U. S. Reduction Co., E. Chicago, Ill.

INHIBITORS [288]
Amer. Cyan. & Chem. Corp., New York
Barium & Chemicals, Inc., Pittsburgh
Char Products Co., Indianapolis, Ind.
Fidelity Chemical Prod. Corp., Newark
E. F. Houghton & Co., Philadelphia, Pa.
J. W. Kelley Co., Cleveland, Ohio
Monsanto Chemical Co., St. Louis
Wm. Parkin Co., Pittsburgh, Pa.
Powder Metallurgy, Inc., Long Island City
Turco Products, Los Angeles

INJECTION MOLDING [289]
Kux Machine Co., Chicago
Lester Engineering Co., Cleveland, Ohio

INSPECTION EQUIPMENT [290]
Amer. Instrument Co., Silver Spring, Md.
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia, Pa.
Bausch & Lomb Opt. Co., Rochester, N. Y.
Brush Development Co., Cleveland, Ohio
Adolph I. Buehler, Chicago, Ill.
Burrell Technical Supply Co., Pittsburgh
Canadian Radium & Uranium Corp., N. Y.
Central Scientific Co., Chicago, Ill.
Dravo Corp., Pittsburgh
DuMont Laboratories, Inc., Allen B., Passaic, N. J.
Engineers Specialties Div., Cleveland
Engineers Specialties Div., Buffalo
General Electric X-Ray Corp., Chicago
Jones Motrola Sales Co., Stamford, Conn.
Kelley-Koett Mfg. Co., Covington, Ky.
Leeds & Northrup Co., Philadelphia, Pa.
Magnaflux Corp., Chicago, Ill.
Magnetic Analysis Corp., Long Island City
North American Philips Co., New York
Physicists Research Co., Ann Arbor, Mich.
Precision Scientific Co., Chicago
Pyrometer Instrument Co., New York
Riehle Testing Machine Div.; American Machine & Metals, Inc., East Moline, Ill.
Sheffield Corp., Dayton, Ohio
Shore Instrument & Mfg. Co., New York
Size Control Co., Chicago
Taber Instr. Co., N. Tonawanda, N. Y.
Thwing-Albert Instr. Co., Philadelphia
Wilson Mech. Instrument Co., New York
"X-Ray Inc.," Detroit

INSTRUMENTS—Recording [291]
Amer. Gas Furnace Co., Elizabeth, N.
Amthor Testing Instr. Co., Brooklyn, N.
Bailey Meter Co., Cleveland, Ohio
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia, Pa.
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Brush Development Co., Cleveland, O.
Builders-Providence, Inc., Providence, R.
Cambridge Instrument Co., Inc., New York
Charles Englehard, Inc., Newark, N. J.
Foxboro Co., Foxboro, Mass.
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago, Ill.
Gotham Instrument Co., New York
Hays Corp., Michigan City, Ind.
Leeds & Northrup Co., Philadelphia, Pa.
Mine Safety Appliances Co., Pittsburgh
Tinius Olsen Testing Mach. Co., Phila.
Physicists Research Co., Ann Arbor, Mich.
Pyrometer Instrument Co., New York
Arklay S. Richards Co., Inc., Newton Highlands, Mass.
Riehle Testing Machine Div.; American Machine & Metals, Inc., East Moline, Ill.
Taber Instr. Corp., N. Tonawanda, N. Y.
C. J. Tagliabue Mfg. Co., Brooklyn, N. Y.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Taylor Instr. Companies, Rochester, N. Y.
Vulcan Corp., Philadelphia
Westinghouse Elec. & Mfg. Co., E. Pgh.
Wheelco Instruments Co., Chicago, Ill.

INSTRUMENTS—Special [292]
Amer. Instrument Co., Silver Spring, Md.
Amer. Optical Co., Southbridge, Mass.
Amthor Testing Inst. Co., Brooklyn, N. Y.
Automatic Temperature Control Co., Philadelphia
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia, Pa.
Bausch & Lomb. Opt. Co., Rochester, N. Y.
Brown Instrument Co., Philadelphia, Pa.
Brush Development Co., Cleveland, O.
Adolph I. Buehler, Chicago, Ill.
Burling Instrument Co., Newark, N. J.
Burrell Technical Supply Co., Pittsburgh
Cambridge Instrument Co., Inc., New York
Central Scientific Co., Chicago, Ill.
John Chatillon & Sons, New York, N. Y.
Continental Industrial Engineers, Chicago
W. R. Cramer & Co., Centerbrook, Conn.
W. C. Dillon & Co., Inc., Chicago
Dravo Corp., Pittsburgh
DuMont Laboratories, Inc., Allen B., Passaic, N. J.
R. A. Ekstrom, Jr., Co., Harvey, Ill.
Foxboro Co., Foxboro, Mass.
Gaertner Scientific Corp., Chicago
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago, Ill.
Adam Hilger, Ltd., London, England
Illinois Testing Lab., Inc., Chicago
Jarrell-Ash Co., Boston, Mass.
J-B-T Instruments, Inc., New Haven, Conn.
Leeds & Northrup Co., Philadelphia, Pa.
E. Leitz, Inc., New York, N. Y.
Mico Instruments Co., Cambridge, Mass.
National Time & Signal Corp., Detroit
Partlow Corp., New Hartford, N. Y.
Pfaltz & Bauer, Inc., New York
Physicists Research Co., Ann Arbor, Mich.
Pitt. Instrument & Mach. Co., Pittsburgh
Precision Scientific Co., Chicago
Pyrometer Instrument Co., New York
Rawson Electrical Instrument Co., Cambridge, Mass.
Arklay S. Richards Co., Inc., Newton Highlands, Mass.
Riehle Testing Machine Div.; American Machine & Metals, Inc., East Moline, Ill.
Spencer Lens Co., Buffalo, N. Y.
F. J. Stokes Machine Co., Philadelphia
Taber Instrument Co., N. Tonawanda, N. Y.
Tate-Jones & Co., Inc., Leetsdale, Pa.
TelAutograph Corp., New York
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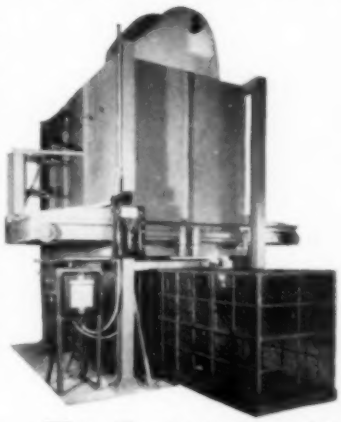

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Wheelco Instruments Co., Chicago, Ill.
Wilkens-Anderson Co., Chicago
"X-Ray Inc.," Detroit
Carl Zeiss, Inc., New York

INSULATING MATERIALS—Elec. [293]
Amer. Lava Corp., Chattanooga, Tenn.
Continental-Diamond Fibre, Newark, Del.
John C. Dolph Co., Newark, N. J.
Driver-Harris Co., Harrison, N. J.
General Electric Co., Schenectady, N. Y.
B. F. Goodrich Co., Akron, Ohio
Johns-Manville, New York, N. Y.
Keasbey & Mattison Co., Ambler, Pa.
Owens-Corning Fiberglas Corp., Toledo, O.
Protective Coatings, Inc., Detroit, Mich.
Tate-Jones & Co., Inc., Leetsdale, Pa.
United Chromium, Inc., New York
Westinghouse Elec. & Mfg. Co., E. Pgh.

INSULATION [294]
Armstrong Cork Co., Lancaster, Pa.
Botfield Refractories Co., Philadelphia, Pa.
Carborundum Co., Perth Amboy, N. J.
Philip Carey Mfg. Co., Lockland, Ohio
Eagle-Picher Sales Co., Cincinnati, O.
General Electric Co., Schenectady, N. Y.
B. F. Goodrich Co., Akron, Ohio
Harbison-Walker Refractories Co., Pittsburgh, Pa.
Illinois Clay Products Co., Joliet, Ill.
Johns-Mansville, New York
Keasbey & Mattison Co., Ambler, Pa.
Owens-Corning Fiberglas Corp., Toledo, O.
Refractory & Insulation Corp., New York
Reynolds Metals Co., Louisville, Ky.
F. E. Schindler Co., Inc., Long Island City
Standard Fuel Engineering Co., Detroit
Tate-Jones & Co., Inc., Leetsdale, Pa.

IRON—Powder [295]
Advance Solvents & Chem. Corp., N. Y.
Ekstrand & Tholand, Inc., New York
Firth-Sterling Steel Co., McKeesport, Pa.
Foote Mineral Co., Philadelphia, Pa.
General Aniline Works Div., New York
Charles Hardy, Inc., New York, N. Y.
Harrison Abrasive Corp., Manchester, N.H.
Metals Disintegrating Co., Elizabeth, N. J.
Metals Refining Co., Hammond, Ind.
Plastic Metals, Inc., Johnstown, Pa.
Powder Metals & Alloys, Inc., New York
Service Machine Co., Elizabeth, N. J.

LABORATORY EQUIP.—Chemical [296]
American Hard Rubber Co., New York
American Inst. Co., Silver Spring, Md.
Burrell Technical Supply Co., Pittsburgh
Central Scientific Co., Chicago, Ill.
Despatch Oven Co., Minneapolis, Minn.
Harry W. Dietert Co., Detroit, Mich.
Duriron Co., Inc., Dayton, O.
Eberbach & Son Co., Ann Arbor, Mich.
Eclipse Air Brush Co., Newark, N. J.
Eimer & Amend, New York
Fisher Scientific Co., Pittsburgh
Harshaw Chemical Co., Cleveland
Hevi Duty Electric Co., Milwaukee, Wis.
Hoskins Mfg. Co., Detroit, Mich.
Jarrell-Ash Co., Boston, Mass.
E. Leitz, Inc., New York
Metals Research Apparatus, Inc., Pgh., Pa.
Pfaltz & Bauer, Inc., New York
Precision Scientific Co., Chicago
R. W. Rhoades Metaline Co., Inc., Long Island City, N. Y.
E. H. Sargent & Co., Chicago, Ill.
Scientific Supplies Co., Seattle, Wash.
Selas Co., Philadelphia, Pa.
Sparkler Mfg. Co., Mundelein, Ill.
Spencer Lens Co., Buffalo, N. Y.
F. J. Stokes Machine Co., Philadelphia, Pa.
Sweden Freezer Mfg. Co., Seattle, Wash.
Taber Instrument Co., N. Tonawanda, N. Y.
Tolhurst Centrifugal Div., E. Moline, Ill.
Wilkens-Anderson Company, Chicago

LABORATORY EQUIP.—Met. [297]
American Inst. Co., Silver Spring, Md.
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia, Pa.
Brush Development Co., Cleveland
Adolph I. Buehler, Chicago, Ill.
Burrell Technical Supply Co., Pittsburgh
Cambridge Instrument Co. Inc., N. Y., N. Y.
Central Scientific Co., Chicago, Ill.
Despatch Oven Co., Minneapolis, Minn.
Harry W. Dietert Co., Detroit
W. C. Dillon & Co., Inc., Chicago
Dravo Corp., Pittsburgh
Eberbach & Son Co., Ann Arbor, Mich.
Eclipse Air Brush Co., Newark, N. J.
Eimer & Amend, New York
R. Y. Ferner Co., Boston, Mass.
Fisher Scientific Co., Pittsburgh
Claud S. Gordon Co., Chicago, Ill.
Harshaw Chemical Co., Cleveland
Hevi Duty Electric Co., Milwaukee, Wis.
Adam Hilger, Ltd., London, Eng.
A. F. Holden Co., West Haven, Conn.
Hoskins Mfg. Co., Detroit, Mich.
Lepel High Freq. Labs., Inc., New York
Metals Research Apparatus, Inc., Pgh., Pa.
Mico Instrument Co., Cambridge, Mass.
G. S. Peterson Co., Cleveland, Ohio
Precision Scientific Co., Chicago
Pyrometer Instrument Co., New York City
Rapid Electroplating Process, Chicago
R. W. Rhoades Metaline Co., Inc., Long Island City, N. Y.
Riehle Testing Machine Div.; American Machine & Metals, Inc., East Moline, Ill.
E. H. Sargent & Co., Chicago, Ill.
George Scherr Co., New York, N. Y.
Scientific Supplies Co., Seattle, Wash.
Selas Co., Philadelphia, Pa.
F. J. Stokes Machine Co., Philadelphia
Sweden Freezer Mfg. Co., Seattle, Wash.
Taber Instr. Corp., N. Tonawanda, N. Y.
C. J. Tagliabue Mfg. Co., Brooklyn, N. Y.
Harold E. Trent Co., Philadelphia, Pa.
"X-Ray Inc.," Detroit

LABORATORY WARE—Filtration [298]
Burrell Technical Supply Co., Pittsburgh
Carborundum Co., Niagara Falls, N. Y.
Central Scientific Co., Chicago, Ill.
Corning Glass Works, Corning, N. Y.
Eberbach & Son Co., Ann Arbor, Mich.
Norton Co., Worcester, Mass.
E. H. Sargent & Co., Chicago, Ill.
Selas Co., Philadelphia, Pa.

LABORATORY WARE—High Temp. [299]
American Inst. Co., Silver Spring, Md.
Baker & Co., Inc., Newark, N. J.
Burrell Technical Supply Co., Pittsburgh
Carborundum Co., Niagara Falls, N. Y.
Central Scientific Co., Chicago, Ill.
Corning Glass Works, Corning, N. Y.
Eberbach & Son Co., Ann Arbor, Mich.
Claud S. Gordon Co., Chicago, Ill.
Norton Co., Worcester, Mass.
E. H. Sargent & Co., Chicago, Ill.
Selas Co., Philadelphia, Pa.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Thermal Syndicate, Ltd., New York

LEAD [300]
Ajax Metal Co., Philadelphia
Anaconda Copper Mining Co., New York
Bearium Metals Corp., Rochester, N. Y.
Duquesne Smelting Corp., Pittsburgh
Eagle-Picher Sales Co., Cincinnati, Ohio
General Electric Co., Schenectady, N. Y.
Metals Refining Co., Hammond, Ind.
National Lead Co., New York
U. S. Smelting, Refining & Mining Co., New York
Whitehead Metal Products Co., New York

LEAD POTS [301]
Alloy Casting Co., Champaign, Ill.
Amer. Electric Furnace Co., Boston, Mass.
Amer. Gas Furnace Co., Elizabeth, N. J.
Amer. Mang. Steel Div., American Brake Shoe Co., Chicago Hts.
Case Hardening Service Co., Cleveland
Chicago Flexible Shaft Co., Chicago
Chicago Steel Foundry Co., Chicago, Ill.
Driver-Harris Co., Harrison, N. J.
Duraloy Co., Scottdale, Pa.
Eagle-Picher Lead Co., Cincinnati, O.
Eclipse Fuel Eng'ring Co., Rockford, Ill.
Electric Furnace Co., Salem, Ohio
Electro Alloys Co., Elyria, Ohio
Fahralloy Co., Harvey, Ill.
Farrel-Birmingham Co., Ansonia, Conn.
General Electric Co., Schenectady, N. Y.
General Alloys Co., Boston, Mass.
Claud S. Gordon Co., Chicago, Ill.
Heatbath Corp., Springfield, Mass.
A. F. Holden Co., West Haven, Conn.
Charles A. Hones, Inc., Baldwin, N. Y.
Hoskins Mfg. Co., Detroit, Mich.
Johnson Gas Appl. Co., Cedar Rapids, Ia.
C. M. Kemp. Mfg. Co., Baltimore, Md.
Lebanon Steel Foundry, Lebanon, Pa.
Mahr Mfg. Co., Minneapolis, Minn.
Meehanite Research Institute, Pgh., Pa.
Michigan Steel Casting Co., Detroit, Mich.
Midvale Co., Nicetown, Philadelphia, Pa.
Morrison Engineering Corp., Cleveland
National Machine Works, Chicago
Powder Metals & Alloys, Inc., New Y
Pressed Steel Co., Wilkes-Barre, Pa.
Selas Co., Philadelphia, Pa.
Sentry Co., Foxboro, Mass.
Standard Alloy Co., Cleveland
Sterling Alloys, Inc., Woburn, Mass.
Surface Combustion, Toledo, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa
Harold E. Trent Co., Philadelphia, P
Vulcan Corp., Philadelphia
Westinghouse Elec. & Mfg. Co., E. P

LEAD POWDERS [302]
Advance Solvents & Chem. Corp., N.
Ekstrand & Tholand, Inc., New York
Charles Hardy, Inc., New York, N. Y.
Metalead Products Corp., San Fran
Metals Disintegrating Co., Elizabeth,
Metals Refining Co., Hammond, Ind.

LOW TEMPERATURE EQUIPM [303]
Brunner Mfg. Co., Utica, N. Y.
Deepfreeze Div., Motor Prod. Corp Chicago
Kold-Hold Mfg. Co., Lansing, Mich.
Leeds & Northrup Co., Philadelphia
Revco, Inc., Deerfield, Mich.
Sweden Freezer Mfg. Co., Seattle, W
Tate-Jones & Co., Inc., Leetsdale, Pa
Wheelco Instruments Co., Chicago

LUBRICANTS [304]
Acheson Colloids Corp., Port Huron,
Alox Corp., Niagara Falls, N. Y.
Carbide & Carbon Chem. Corp., New
C. H. Clark Oil Co., Cleveland
Joseph Dixon Crucible Co., Jersey N. J.
Gulf Oil Corp., Pittsburgh, Pa.
Gulf Refining Co., Pittsburgh, Pa.
Fiske Bros. Refining Co., Newark, N.
Glyco Products Co., Inc., Brooklyn,
E. F. Houghton & Co., Philadelphia,
J. W. Kelley Co., Cleveland, Ohio
Keystone Lubricating Co., Phila., Pa.
Mico Instrument Co., Cambridge, M
National Graphite Co., New York
N. Y. & N. J. Lubricant Co., New Y
Protective Coatings, Inc., Detroit
Pure Oil Co., Chicago
Rex Oil & Chemical Co., Cleveland
Shell Oil Co., New York
Socony-Vacuum Oil Co., New York
Standard Oil Co., Chicago, Ill.
D. A. Stuart Oil Co., Chicago, Ill.
Sun Oil Co., Philadelphia, Pa.
Tide Water Associated Oil Co., New Y
U. S. Graphite Co., Saginaw, Mich.
Warren Ref. & Chem. Co., Cleveland

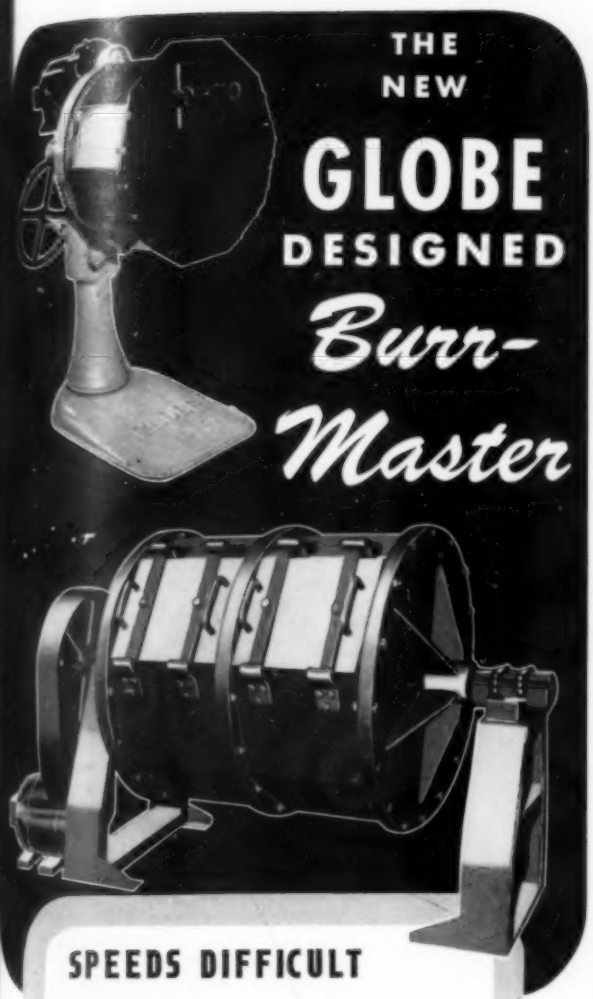
LUBRICATING SYSTEMS—Mechani [305]
Blaw-Knox Co., Pittsburgh, Pa.
Bowser, Inc., Ft. Wayne, Ind.
Torrington Mfg. Co., Torrington, Conn
Trabon Engineering Corp., Cleveland

MAGNESITE REFRACTORIES [306]
Basic Refractories, Inc., Cleveland
General Refractories Co., Philadelphia
Harbison-Walker Refrac. Co., Pittsbu
Lava Crucible Co. of Pittsburgh
Tate-Jones & Co., Inc., Leetsdale, Pa.

MAGNESIUM [307]
Aluminum Co. of America, Pittsburgh
Amer. Magnesium Corp., Pittsburgh,
Apex Smelting Co., Chicago
Dow Chemical Co., Midland, Mich.
Norton Co., Worcester, Mass.

MANGANESE METAL, ALLOYS [30
Ajax Metal Co., Philadelphia
Apex Smelting Co., Chicago
Callite Tungsten Corp., Union City, N
W. M. Chace Co., Detroit, Mich.
Wilbur B. Driver Co., Newark, N. J.
Driver-Harris Co., Harrison, N. J.
Electro Manganese Corp., Minneapolis
Electro Metallurgical Co., New York
Foote Mineral Co., Philadelphia
General Alloys Co., Boston, Mass.
Howard Foundry Co., Chicago
Ingersoll Steel & Disc Div., Borg-Warn Corp., New Castle, Ind.
Metal & Thermit Corp., New York
Metallurgical Products Co., Philadelp
Niagara Falls Smelting & Refining Co Buffalo
Ohio Ferro Alloys Corp., Canton, Ohio
Pittsburgh Metallurgical Co., Inc., Nia Falls, N. Y.
Taylor-Wharton Iron & Steel Co., Eas Pennsylvania and High Bridge, N.

See Advertisement of Companies in Bold-Face Type for Further Information



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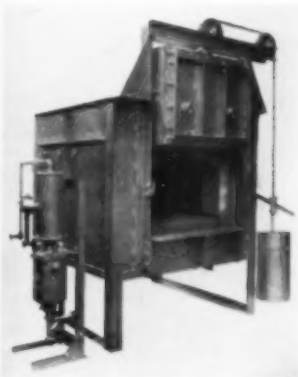
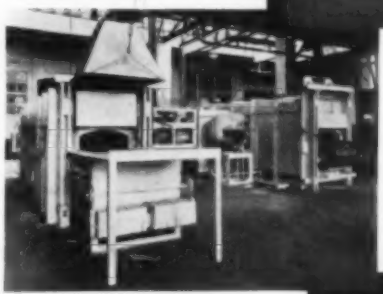


Faster treatment cycles, closer temperature uniformity, greater ease in handling even the heaviest charges, and construction that stands firm under continuous operation, are features that recommend VULCAN Furnaces for every heating and heat treating purpose.

★ ★ ★

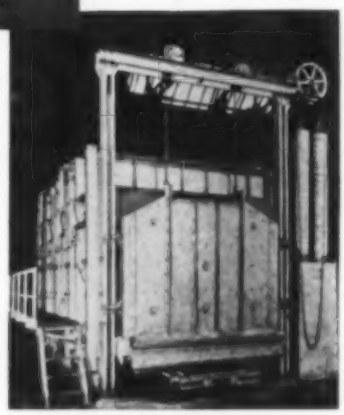
Left—VULCAN Box Type Furnace for various heating and heat treating operations at temperatures from 800° F. to 1750° F. Controlled atmosphere. Oil, gas or electric. Can be arranged for semi-continuous operation.

Right—VULCAN Salt Bath Furnace for quantity production of alloy steel parts and tools. Electrically heated by internal immersion heaters (illustrated), external radiant heaters or immersed electrodes. May also be oil or gas fired.



Left — VULCAN Automatic Hardening, Quenching and Drawing Unit for treating miscellaneous steel castings and forgings. One-man operation. Oil or gas fired, or equipped with radiant tubes or electric heaters for clean hardening. Capacity: one ton per hour.

Right—VULCAN Car Hearth Furnace for heat treating by quenching in air, oil or water from car at temperatures up to 2000° F., drawing at temperatures down to 600° F., and annealing and normalizing at 1750° F. Complete control. Oil or gas fired.



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Consult VULCAN Engineers, without obligation. Their recommendations will be based on many successful installations.

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MARKING EQUIPMENT [309]
H. P. Preis Engraving Machine Co., Newark, N. J.
Geo. T. Schmidt, Inc., Chicago

MESH CLOTH & BELTING [310]
Audubon Wire Cloth Corp., Philadelphia
Chase Brass & Cop. Co., Waterbury, Conn.
Cyclone Fence Div., Amer. Steel & Wire Co., Waukegan, Ill.
Driver-Harris Co., Harrison, N. J.
Rolock, Inc., Fairfield, Conn.
Vulcan Corp., Philadelphia

METAL CHILLING EQUIPMENT [310A]
Amer. Instrument Co., Silver Spring, Md.
Kold-Hold Mfg. Co., Lansing, Mich.
Tate-Jones & Co., Inc., Leetsdale, Pa.

METAL CLEANING COMPOUNDS [311]
Amer. Cyanamid & Chem. Corp., New York
Carbide & Carbon Chem. Corp., New York
Circo Products Co., Cleveland
Colonial Alloys Co., Philadelphia
Cowles Detergent Co., Cleveland, Ohio
Crown Rheostat & Supply Co., Chicago
Detroit Rex Products Co., Detroit, Mich.
E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Fidelity Chemical Prod. Corp., Newark
Gulf Oil Corp., Pittsburgh, Pa.
Heatbath Corp., Springfield, Mass.
A. F. Holden Co., West Haven, Conn.
E. F. Houghton & Co., Philadelphia, Pa.
Maas & Waldstein Co., Newark, N. J.
W. D. MacDermid Chem. Co., Bristol, Conn.
Magnus Chemical Co., Inc., Garwood, N. J.
Magnuson Products Corp., Brooklyn, N. Y.
Mathieson Alkali Works, New York
Mercury Chemical Co., Inc., Detroit
Minnesota Mining & Mfg. Co., St. Paul, Minn.
Monsanto Chemical Co., St. Louis
Park Chemical Co., Detroit, Mich.
Pennsylvania Salt Mfg. Co., Philadelphia
Philadelphia Quartz Co., Philadelphia
Phillips Mfg. Co., Chicago, Ill.
Puritan Mfg. Co., Waterbury, Conn.
Quaker Chem. Products Corp., Conshohocken, Pa.
Solventol Chemical Products, Inc., Detroit
Technical Processes Division of Colonial Alloys, Philadelphia, Pa.
Turco Products, Inc., Los Angeles, Calif.
Warren Ref. & Chem. Co., Cleveland
Wyandotte Chem. Corp., Wyandotte, Mich.

METAL CUTTING SAWS—See Saws

METAL POWDERS [312]
Advance Solvents & Chem. Corp., N. Y.
Aluminum Co. of Amer., Pittsburgh, Pa.
Amer. Electro Metal Corp., Yonkers, N. Y.
Amer. Solder & Flux Co., Philadelphia, Pa.
Callite Tungsten Corp., Union City, N. J.
Ekstrand & Tholand, Inc., New York
Firth-Sterling Steel Co., McKeesport, Pa.
Foote Mineral Co., Philadelphia, Pa.
General Aniline Works, New York
General Metals Powder Co., Akron, Ohio
Handy & Harman, New York, N. Y.
Charles Hardy, Inc., New York, N. Y.
Indium Corp. of America, New York
Johns-Manville, New York
Krembs & Co., Chicago
Metal Hydrides, Inc., Beverly, Mass.
Metals Disintegrating Co., Elizabeth, N. J.
Metals Refining Div., Hammond, Ind.
Molybdenum Corp. of Amer., Pittsburgh
Moraine Products Div., Dayton, O.
New Jersey Zinc Co., New York
Pittsburgh Crushed Steel Co., Pgh., Pa.
Plastic Metals, Inc., Johnstown, Pa.
Powder Metals & Alloys, Inc., New York
Reynolds Metals Co., Louisville, Ky.

METAL SHRINKING EQUIPMENT [313]
Tate-Jones & Co., Inc., Leetsdale, Pa.

METAL SPRAYING EQUIPMENT [314]
Driver-Harris Co., Harrison, N. J.
Metallizing Co. of America, Chicago
Metallizing Eng. Co., Long Island City, New York
Paasche Airbrush Co., Chicago, Ill.

METALLIC COATINGS—Corrosion Prev. [315]
Alrose Chemical Co., Providence, R. I.
Amer. Solder & Flux Co., Phila., Pa.
Apollo Metal Works, Chicago
Heil Engineering Co., Cleveland
Indium Corp. of America, New York, N. Y.
Maas & Waldstein Co., Newark, N. J.
Metallizing Eng. Co., Long Island City, New York
Mitchell-Bradford Chem. Co., Bridgeport, Conn.
Protective Coatings, Inc., Detroit
Reynolds Metals Co., Louisville, Ky.
United Chromium, Inc., New York

METALLOGRAPHIC EQUIPMENT [316]
Amer. Instrument Co., Silver Spring, Md.
Bausch & Lomb Opt. Co., Rochester, N. Y.
Adolph I. Buehler, Chicago, Ill.
Burrell Technical Supply Co., Pittsburgh
Canadian Radium & Uranium Corp., N. Y.
Central Scientific Co., Chicago, Ill.
Eastman Kodak Co., Rochester, N. Y.
Eberbach & Son Co., Ann Arbor, Mich.
R. Y. Ferner Co., Boston, Mass.
Fisher Scientific Co., Pittsburgh
General Electric X-Ray Corp., Chicago
Claud S. Gordon Co., Chicago, Ill.
Precision Scientific Co., Chicago
George Scherr Co., Inc., New York
E. H. Sargent & Co., Chicago, Ill.
Spencer Lens Co., Buffalo, N. Y.

METALLOGRAPHIC APPARATUS [317]
American Inst. Co., Silver Spring, Md.
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia, Pa.
Adolph I. Buehler, Chicago, Ill.
Burrell Technical Supply Co., Pittsburgh
W. C. Dillon & Co., Inc., Chicago
Eastman Kodak Co., Rochester, N. Y.
Eberbach & Son Co., Ann Arbor, Mich.
Fisher Scientific Co., Pittsburgh
Claud S. Gordon Co., Chicago, Ill.
Precision Scientific Co., Chicago
E. H. Sargent & Co., Chicago, Ill.
Wilson Mech. Instr. Co., Inc., New York

MET. MICROSCOPES [318]
American Inst. Co., Silver Spring, Md.
Bausch & Lomb Opt. Co., Rochester, N. Y.
A. I. Buehler, Chicago, Ill.
Burrell Technical Supply Co., Pittsburgh
Eberbach & Son Co., Ann Arbor, Mich.

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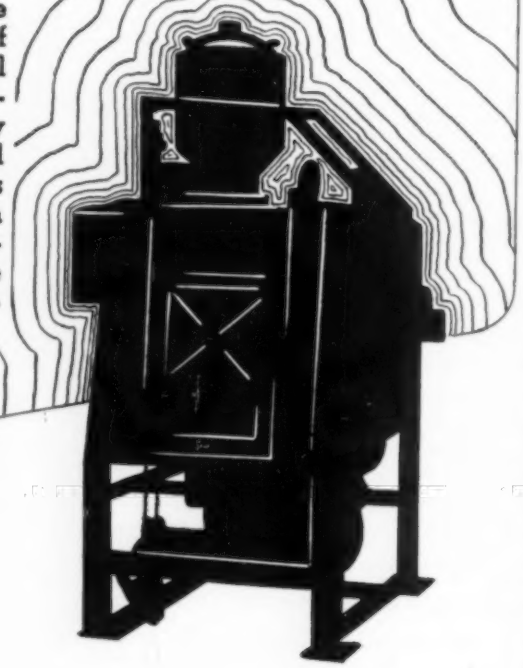

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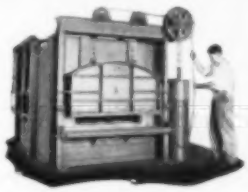

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George Scherr Co., New York, N. Y.
Spencer Lens Co., Buffalo, N. Y.
Carl Zeiss, Inc., New York

METALS—Babbitt—See Babbitt Metals

METALS—Pre-Finished [319]
American Nickeloid Co., Peru, Illinois
Apollo Metal Works, Chicago
Chase Brass & Cop. Co., Waterbury, Conn.
Gilbert Cummins & Co., Baltimore, Md.
Reynolds Metals Co., Louisville, Ky.

METERS—Air Velocity [320]
Brown Instrument Co., Philadelphia, Pa.
Foxboro Co., Foxboro, Mass.
Tate-Jones & Co., Inc., Leetsdale, Pa.

METERS—Electric Welding [321]
General Electric Co., Schenectady, N. Y.
Lincoln Electric Co., Cleveland, Ohio
Universal Power Corp., Cleveland

METERS—Flow [322]
Amer. Gas Furnace Co., Elizabeth, N. J.
Bailey Meter Co., Cleveland, Ohio
S. F. Bowser & Co., Inc., Ft. Wayne, Ind.
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Builders-Providence, Inc., Providence, R.I.
Fischer & Porter Co., Hatboro, Pa.
Foxboro Co., Foxboro, Mass.
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago, Ill.
Hays Corp., Michigan City, Ind.
Leeds & Northrup Co., Philadelphia, Pa.
Selas Co., Philadelphia, Pa.
C. J. Tagliabue Mfg. Co., Brooklyn, N. Y.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Taylor Instr. Companies, Rochester, N. Y.
Worthington Pump & Machinery Corp., Harrison, N. J.

METERS—Gas or Air [323]
Bailey Meter Co., Cleveland, Ohio
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Builders-Providence, Inc., Providence, R. I.
Foxboro Co., Foxboro, Mass.
E. A. Furkert Co., Chicago
Roots-Connersville Blower Corp., Connersville, Ind.
Selas Co., Philadelphia, Pa.
Sprague Meter Co., Bridgeport, Conn.
C. J. Tagliabue Mfg. Co., Brooklyn, N. Y.
Tate-Jones & Co., Inc., Leetsdale, Pa.

MICROSCOPES [324]
American Inst. Co., Silver Spring, Md.
Bausch & Lomb Opt. Co., Rochester, N. Y.
A. I. Buehler, Chicago, Ill.
Burrell Technical Supply Co., Pittsburgh
Central Scientific Co., Chicago, Ill.
Eberbach & Son Co., Ann Arbor, Mich.
Fisher Scientific Co., Pittsburgh
Claud S. Gordon Co., Chicago, Ill.
Adam Hilger, Ltd., London, England
Pittsburgh Instrument & Machine Co., Pittsburgh, Pa.
E. H. Sargent & Co., Chicago, Ill.
Geo. Scherr Co., New York, N. Y.
Spencer Lens Co., Buffalo, N. Y.
Steel City Testing Laboratory, Detroit
Carl Zeiss, Inc., New York

MIXING EQUIPMENT [325]
Alsop Engineering Corp., Milldale, Conn.
Eclipse Air Brush Co., Newark, N. J.
Globe Machine & Stamping Co., Cleveland
Lancaster Iron Works, Inc., Lancaster, Pa.
Sprout Waldron & Co., Muncy, Pa.
Tate-Jones & Co., Inc., Leetsdale, Pa.

MOLDING MACHINES [326]
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia, Pa.
Fisher Scientific Co., Pittsburgh
Johnston & Jennings Co., Cleveland
Kux Machine Co., Chicago
Lester Engineering Co., Cleveland, Ohio
Osborn Mfg. Co., Cleveland, Ohio
F. J. Stokes Machine Co., Philadelphia, Pa.
Tabor Mfg. Co., Philadelphia, Pa.

MOLTEN METAL TREATMENT [327]
Am. Gas Furnace Co., Elizabeth, N. J.
Barium & Chemicals, Inc., Pittsburgh, Pa.
Continental Industrial Engineers, Chicago
Foundry Services, Inc., New York City
A. F. Holden Co., West Haven, Conn.
E. F. Houghton & Co., Philadelphia, Pa.
C. U. Scott & Son, Rock Island, Ill.
Steel Treating Equipment Co., Detroit
Vulcan Corp., Philadelphia

MOLYBDENUM [328]
Callite Tungsten Corp., Union City, N. J.
Ekstrand & Tholand, Inc., New York
Fansteel Metallurgical Corp., N. Chicago
Foote Mineral Co., Philadelphia, Pa.
Charles Hardy, Inc., New York, N. Y.
P. R. Mallory & Co., Indianapolis, Ind.
Metallurgical Products Co., Philadelphia
Molybdenum Corp. of Amer., Pittsburgh
Powder Metals & Alloys, Inc., New York
H. A. Wilson Co., Newark, N. J.

MUFFLES—Refractory [329]
Alloy Casting Co., Champaign, Ill.
Amer. Gas Furnace Co., Elizabeth, N. J.
American Mang. Steel Div., Amer. Brake Shoe Co., Chicago Hts., Ill.
Amsler-Morton Co., Pittsburgh, Pa.
Burrell Technical Supply Co., Pittsburgh
Carborundum Co., Perth Amboy, N. J.
Chicago Flexible Shaft Co., Chicago
Electro Refract. & Alloys Corp., Buffalo
Fisher Scientific Co., Pittsburgh
Gas Machinery Co., Cleveland
General Alloys Co., Boston, Mass.
Claud S. Gordon Co., Chicago, Ill.
Harbison-Walker Refractories Co., Pgh.
Johns-Manville, New York
Lava Crucible Co. of Pittsburgh
Norton Co., Worcester, Mass.
F. E. Schundler & Co., Long Island City
Chas. Taylor Sons Co., Cincinnati, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.
Thermal Syndicate, Ltd., New York
Vulcan Corp., Philadelphia

NICKEL & NICKEL ALLOYS [330]
Ajax Metal Co., Philadelphia
American Brass Co., Waterbury, Conn.
Brown-Wales Co., Boston, Mass.
Burgess-Parr Co., Freeport, Ill.
Callite Tungsten Corp., Union City, N. J.
Carpenter Steel Co., Reading, Pa.
John Chatillon & Sons, New York, N. Y.
Chicago Steel Foundry Co., Chicago, Ill.
Wilbur B. Driver Co., Newark, N. J.
Driver-Harris Co., Harrison, N. J.
Duraloy Co., Scottdale, Pa.
Duriron Co., Inc., Dayton, O.
Electro Alloys Co., Elyria, O.
General Alloys Co., Boston, Mass.
Haynes Stellite Co., Kokomo, Ind.
Hoskins Mfg. Co., Detroit, Mich.
International Nickel Co., New York
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Niagara Falls Smelting & Refining Corp., Buffalo, N. Y.
Ohio Steel Foundry Co., Springfield, O.
Revere Copper & Brass, Inc., New York
Arklay S. Richards Co., Inc., Newton Highlands, Mass.
Riverside Metal Co., Riverside, N. J.
Jos. T. Ryerson & Son, Inc., Chicago
Western Cartridge Co., East Alton, Ill.
Wheelock, Lovejoy & Co., Inc., Cambridge, Mass.
Whitehead Metal Products Co., New York
Williams & Co., Pittsburgh

NICKEL CLOTH & BELTS [331]
Audubon Wire Cloth Corp., Philadelphia
Cyclone Fence Div., Amer. Steel & Wire Co., Waukegan, Ill.
Driver-Harris Co., Harrison, N. J.
Newark Wire Cloth Co., Newark, N. J.
Rolock, Inc., Fairfield, Conn.

NICKEL POWDERS [332]
Ekstrand & Tholand, Inc., New York
Charles Hardy, Inc., New York, N. Y.
International Nickel Co., New York
Metals Disintegrating Co., Elizabeth, N. J.
Powder Metals & Alloys, Inc., New York

NICKEL—Welding Rods [333]
Air Reduction, New York
Allied Weld-craft, Inc., Indianapolis, Ind.
Arcos Corp., Philadelphia, Pa.
Driver-Harris Co., Harrison, N. J.
Eutectic Welding Alloys, Inc., New York
Harnischfeger Corp., Milwaukee, Wis.
Hoskins Mfg. Co., Detroit, Mich.
International Nickel Co., New York
Lincoln Electric Co., Cleveland
National Cylinder Gas Co., Chicago, Ill.
Page Steel & Wire Div., Amer. Chain & Cable Co., Monessen, Penna.
Revere Copper & Brass, Inc., New York
Jos. T. Ryerson & Son, Inc., Chicago
Universal Power Corp., Cleveland
Whitehead Metal Products Co., New York

NITROGEN [334]
Air Reduction Sales Co., New York
Linde Air Products Co., New York
National Cylinder Gas Co., Chicago, Ill.

NON-FERROUS ALLOYS—See Alloys—Non-Ferrous

NOZZLES—Oxy-Acetylene Cutting [335]
Air Reduction, New York
General Welding & Equip. Co., Boston
Harris Calorific Co., Cleveland, Ohio
Linde Air Products Co., New York
National Cylinder Gas Co., Chicago, Ill.
Smith Welding Equip. Corp., Minneapolis
Universal Power Corp., Cleveland
Victor Equip. Co., San Francisco, Calif.

NOZZLES—Sand Blasting [336]
Amer. F'dry Equip. Co., Mishawaka, Ind.
Dreisbach Engr. Corp., Yonkers, N. Y.
McCauley Alloy Co., Chicago Hts., Ill.
Norton Co., Worcester, Mass.
Pangborn Corp., Hagerstown, Md.
Parsons Engr. Corp., Cleveland, Ohio
W. W. Sly Mfg. Co., Cleveland, Ohio
Universal Power Corp., Cleveland

NUT MAKING MACHINES [337]
Acme Mach. Div., Hill Acme Co., Cleve., O.
National Machinery Co., Tiffin, Ohio
Poulsen & Nardon, Inc., Los Angeles

NUTS—Special or Spring Steel [338]
American Steel & Wire Co., Cleveland
Bethlehem Steel Co., Bethlehem, Pa.
Columbia Steel Co., San Francisco, Calif.
Driver-Harris Co., Harrison, N. J.
Poulsen & Nardon, Inc., Los Angeles
Republic Steel Corp., Cleveland
Tinnerman Products, Inc., Cleveland, Ohio
U. S. Steel Supply Co., Chicago

OIL BURNERS—See Burners

OIL COOLERS [339]
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Amer. Locomotive Co., Schenectady, N. Y.
Bell and Gossett Co., Morton Grove, Ill.
Brown Fintube Co., Elyria, Ohio
Case Hardening Service Co., Cleveland
Frostrode Products, Detroit
Claud S. Gordon Co., Chicago, Ill.
Griscom-Russell Co., New York
Lindberg Engineering Co., Chicago, Ill.
Niagara Blower Co., New York
Ross Heater & Mfg Co., Inc., Buffalo, N. Y.
Salem Engineering Co., Salem, O.
Sims Co., Erie, Pa.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia
Whitlock Mfg. Co., Hartford, Conn.

OIL TESTING INSTRUMENTS [340]
American Inst. Co., Silver Spring, Md.
Burrell Technical Supply Co., Pittsburgh
Central Scientific Co., Chicago, Ill.
Eberbach & Son Co., Ann Arbor, Mich.
Claud S. Gordon Co., Chicago, Ill.
E. H. Sargent & Co., Chicago, Ill.
Sperry Products, Inc., Hoboken, N. J.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Westinghouse Elec. & Mfg. Co., E. Pgh.
Carl Zeiss, Inc., New York

OILS—Cutting—See Cutting Oils

OILS—Lubricating—See Lubricants

OILS—Quenching [341]
Case Hardening Service Co., Cleveland
C. H. Clark Oil Co., Cleveland
Farrar Indust. Prod. Co., Los Angeles, Cal.
Gulf Oil Corp., Pittsburgh, Pa.
Gulf Refining Co., Pittsburgh
E. F. Houghton & Co., Philadelphia, Pa.
J. W. Kelley Co., Cleveland, Ohio
Keystone Lubricating Co., Philadelphia
Park Chemical Co., Detroit, Mich.
Quaker Chemical Products Corp., Conshohocken, Pa.
Rex Oil & Chemical Co., Cleveland
Rodman Chemical Co., Verona, Pa.
G. S. Rogers & Co., Chicago, Ill.
Shell Oil Co., Inc., New York
Socony Vacuum Oil Co., New York
Standard Oil Co., Chicago, Ill.
Steel Treating Equipment Co., Detroit
D. A. Stuart Oil Co., Chicago, Ill.
Sun Oil Co., Philadelphia, Pa.
Swan-Finch Oil Corp., New York, N. Y.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Tide Water Associated Oil Co., New York
Warren Ref. & Chem. Co., Cleveland

OPTICAL INSTRUMENTS [342]
American Inst. Co., Silver Spring, Md.
Amer. Optical Co., Southbridge, Mass.
Bausch & Lomb Opt. Co., Rochester, N. Y.

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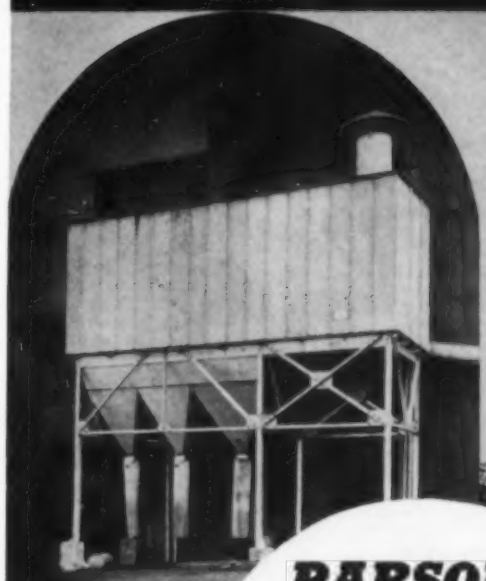

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Claud S. Gordon Co., Chicago, Ill.
E. Leitz, Inc., New York
Pyrometer Instrument Co., New York
E. H. Sargent & Co., Chicago, Ill.
George Scherr Co., New York, N. Y.
Scientific Supplies Co., Seattle, Wash.
Spencer Lens Co., Buffalo, N. Y.
Carl Zeiss, Inc., New York

OVENS—Core and Mold [343]
Amer. Gas Assn., New York, N. Y.
Bissett Steel Co., Cleveland
Carl-Mayer Corp., Cleveland, Ohio
Continental Industrial Engineers, Chicago
Despatch Oven Co., Minneapolis, Minn.
Harry W. Dietert Co., Detroit, Mich.
Eclipse Fuel Engineering Co., Rockford, Ill.
Foundry Equipment Co., Cleveland, Ohio
Gehnrich Corp., Long Island City, N. Y.
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McCann Furnace Co., Cleveland, Ohio
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Morrison Engineering Corp., Cleveland
Precision Scientific Co., Chicago
R-S Products Corp., Philadelphia, Pa.
J. O. Ross Engineering Corp., New York
Selas Co., Philadelphia, Pa.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Harold E. Trent Co., Philadelphia, Pa.
Vulcan Corp., Philadelphia
Young Brothers Co., Detroit

OVENS—Enameling, Baking [344]
Amer. Gas Assn., New York, N. Y.
Amer. Gas Furnace Co., Elizabeth, N. J.
Bissett Steel Co., Cleveland
Carl-Mayer Corp., Cleveland, Ohio
Continental Industrial Engineers, Chicago
Despatch Oven Co., Minneapolis, Minn.
Detroit Rex Products Co., Detroit, Mich.
Fostoria Pressed Steel Co., Fostoria, Ohio
Foundry Equipment Co., Cleveland, Ohio
Gehnrich Corp., Long Island City, N. Y.
Claud S. Gordon Co., Chicago, Ill.
Kirk and Blum Mfg. Co., Cincinnati, Ohio
James H. Knapp Co., Los Angeles, Cal.
Lanly Co., Cleveland, Ohio
Industrial Oven Eng. Co., Cleveland, Ohio
Paul Maehler Co., Chicago
Mahr Mfg. Co., Minneapolis, Minn.
Morrison Engineering Corp., Cleveland
J. O. Ross Engineering Corp., New York
Selas Co., Philadelphia, Pa.
Surface Combustion, Toledo, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia
Lee Wilson Engrg. Co., Cleveland, Ohio
Young Brothers Co., Detroit

OVENS—Laboratory [345]
Amer. Gas Furnace Co., Elizabeth, N. J.
American Inst. Co., Silver Spring, Md.
Burrell Technical Supply Co., Pittsburgh
Carl-Mayer Corp., Cleveland, Ohio
Despatch Oven Co., Minneapolis, Minn.
Harry W. Dietert Co., Detroit, Mich.
Eclipse Fuel Engineering Co., Rockford, Ill.
Fisher Scientific Co., Pittsburgh
Gehnrich Corp., Long Island City, N. Y.
Claud S. Gordon Co., Chicago, Ill.
Charles A. Hones, Inc., Baldwin, N. Y.
Industrial Oven Eng. Co., Cleveland, Ohio
Lanly Co., Cleveland, Ohio
Paul Maehler Co., Chicago
Mahr Manufacturing Co., Minneapolis
Morrison Engineering Corp., Cleveland
Pereny Equipment Co., Columbus, Ohio
Precision Scientific Co., Chicago
Proctor & Schwartz, Inc., Phila., Pa.
E. H. Sargent & Co., Chicago, Ill.
Surface Combustion, Toledo, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.
Harold E. Trent Co., Philadelphia, Pa.
Vulcan Corp., Philadelphia
Young Brothers Co., Detroit

OXYGEN [346]
Acetylene Gas Co., St. Louis, Mo.
Air Reduction, New York
Linde Air Products Co., New York
National Cylinder Gas Co., Chicago

PERMANENT MAGNETS [347]
Cinaudagraph Corp., Stamford, Conn.
General Electric Co., Schenectady, N. Y.
Indiana Steel Prod. Co., Valparaiso, Ind.
Michiana Prod. Corp., Michigan City, Ind.
Taylor-Wharton Iron & Steel Co., High Bridge, N. J.

PHOTOMICROGRAPHIC EQUIPMENT—See Metallographic Equipment

PICKLING BASKETS & CRATES [348]
Alloy Casting Co., Champaign, Ill.
American Hard Rubber Co., New York
Amer. Mang. Steel Div., American Brake Shoe Co., Chicago Hts.
Ampco Metal, Inc., Milwaukee, Wis.
Audubon Wire Cloth Corp., Philadelphia
Chicago Steel Foundry Co., Chicago
Driver-Harris Co., Harrison, N. J.
Duriron Co., Inc., Dayton, O.
General Alloys Co., Boston, Mass.
A. F. Holden Co., West Haven, Conn.
Hoskins Mfg. Co., Detroit, Mich.
Kirk and Blum Mfg. Co., Cincinnati, Ohio
Logan Co., Louisville, Ky.
MacDermid, Inc., Waterbury, Conn.
Pressed Steel Co., Wilkes-Barre, Pa.
Rolock, Inc., Fairfield, Conn.
Standard Alloy Co., Cleveland
Stanwood Corp., Chicago
Sterling-Alloys, Inc., Woburn, Mass.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Union Steel Products Co., Albion, Mich.
Whitehead Metal Products Co., New York

PICKLING COMPOUNDS [349]
Fidelity Chemical Prod. Corp., Newark
E. F. Houghton & Co., Philadelphia, Pa.
Kelite Products, Inc., Los Angeles
Maas & Waidstein Co., Newark, N. J.
MacDermid, Inc., Waterbury, Conn.
Monsanto Chemical Co., St. Louis, Mo.
Tate-Jones & Co., Inc., Leetsdale, Pa.

PICKLING MACHINES [350]
Alvey-Ferguson Co., Cincinnati, O.
G. S. Blakeslee & Co., Chicago, Ill.
Bullard-Dunn Process Div., Bullard Co., Bridgeport, Conn.
Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.
Continental Industrial Engineers, Chicago
Crown Rheostat & Supply Co., Chicago
Flinn & Dreffein Co., Chicago, Ill.
Howard Engr. & Mfg. Co., Cincinnati
MacDermid, Inc., Waterbury, Conn.
Meaker Co., Chicago, Ill.
Mesta Machine Co., Pittsburgh, Pa.
Metalwash Machinery Co., Irvington, N. J.
N. Ransohoff, Inc., Cincinnati, Ohio
Salem Engineering Co., Salem, O.
Submerged Comb. Co. of Amer., New York
Tate-Jones & Co., Inc., Leetsdale, Pa.

PICKLING TANKS [351]
Amer. Hard Rubber Co., New York, N. Y.
Atlas Mineral Prod. Co., Mertztown, Pa.
Eclipse Fuel Engr. Co., Rockford, Ill.
Flinn & Dreffein Co., Chicago, Ill.
B. F. Goodrich Co., Akron, Ohio
Haveg Corp., Newark, Delaware
Heil Engineering Co., Cleveland
MacDermid, Inc., Waterbury, Conn.
Manhattan Rubber Mfg. Div., Raybestos-Manhattan, Inc., Passaic, N. J.
National Carbon Co., Inc., New York
Pennsylvania Salt Mfg. Co., Philadelphia
Pittsburgh Plate Glass Co., Pittsburgh, Pa.
N. Ransohoff, Inc., Cincinnati, Ohio
Rolock, Inc., Fairfield, Conn.
Stanwood Corp., Chicago
Tate-Jones & Co., Inc., Leetsdale, Pa.

PIG IRON [352]
Alan Wood Steel Co., Conshohocken, Pa.
Amer. Steel & Wire, Cleveland, Ohio
Bethlehem Steel Co., Bethlehem, Pa.
Carnegie-Illinois Steel Corp., Pgh., Pa.
Columbia Steel Co., San Francisco, Calif.
Inland Steel Co., Chicago
Jackson Iron & Steel Co., Jackson, Ohio
Miller & Co., Chicago
National Steel Corp., Pittsburgh, Pa.
National Tube Co., Pittsburgh
Pittsburgh Steel Co., Pittsburgh, Pa.
Republic Steel Corp., Cleveland, Ohio
Tenn. Coal, Iron & R. R. Co., Birm., Ala.
Youngstown Sheet & Tube Co., Youngstown, O.

PIPE—See Tubing

PIPE—Asbestos & Cement [353]
Brown-Wales Co., Boston, Mass.
Philip Carey Mfg. Co., Lockland, Ohio
Johns-Manville, New York
Keasbey & Mattison Co., Ambler, Pa.

PIPE—Brass & Copper [354]
American Brass Co., Waterbury, Conn.
Chase Brass & Cop. Co., Waterbury, Conn.
Mueller Brass Co., Port Huron, Mich.
Revere Copper & Brass Co., New York
Whitehead Metal Products Co., New York
Wolverine Tube Co., Detroit

PIPE—Centrifugally Cast [355]
American Cast Iron Pipe Co., Birmingham, Ala.
Bethlehem Steel Co., Bethlehem, Pa.
Calorizing Co., Pittsburgh, Pa.
Duraloy Co., Scottdale, Pa.
Michigan Steel Casting Co., Detroit
Ohio Steel Foundry Co., Springfield, O.
Shenango-Penn Mold Co., Dover, Ohio

PIPE—Corrosion Resistant [356]
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Alloy Casting Co., Champaign, Ill.
Alloy Mfg. Co., Inc., Pittsburgh, Pa.
Aluminum Co. of Amer., Pittsburgh, Pa.
American Cast Iron Pipe Co., Birmingham, Ala.
Amer. Hard Rubber Co., New York
Babcock & Wilcox Tube, Beaver Falls, Pa.
Bethlehem Steel Co., Bethlehem, Pa.
Burgess-Parr Co., Freeport, Ill.
A. M. Byers Co., Pittsburgh, Pa.
Carpenter Steel Co., Reading, Pa.
Chase Brass & Cop. Co., Waterbury, Conn.
Chicago Steel Foundry Co., Chicago, Ill.
Columbia Steel Co., San Francisco, Calif.
Continental-Diamond Fibre, Newark, Del.
Cooper Alloy Foundry Co., Hillside, N. J.
Driver-Harris Co., Harrison, N. J.
Duraloy Co., Scottdale, Pa.
Duriron Co., Inc., Dayton, O.
Fischer & Porter Co., Hatboro, Pa.
General Alloys Co., Boston, Mass.
Haynes Stellite Co., Kokomo, Ind.
Haveg Corp., Newark, Delaware
Heil Engineering Co., Cleveland
International Nickel Co., New York, N. Y.
Johns-Manville, New York
M. W. Kellogg Co., Jersey City, N. J.
Lebanon Steel F'dry, Lebanon, Pa.
McCauley Alloy Co., Chicago Heights, Ill.
Metalloy Products Co., Los Angeles, Calif.
Michigan Steel Casting Co., Detroit, Mich.
National Carbon Co., Inc., Cleveland
National Carbon Co., Inc., New York
National Tube Co., Pittsburgh, Pa.
Pittsburgh Steel Co., Pittsburgh, Pa.
Horace T. Potts Co., Philadelphia, Pa.
Pressed Steel Co., Wilkes-Barre, Pa.
Republic Steel Corp., Cleveland, Ohio
Revere Copper & Brass, Inc., New York
Jos. T. Ryerson & Son, Inc., Chicago
Timken Roller Bearing Co., Canton, O.
Tube Reducing Corp., Wallington, N. J.
Whitehead Metal Products Co., New York
Youngstown Sheet & Tube Co., Youngstown, O.

PIPE—Rubber Lined [357]
Amer. Hard Rubber Co., New York
B. F. Goodrich Co., Akron, O.
Heil Engineering Co., Cleveland
Manhattan Rubber Mfg. Div., Raybestos-Manhattan, Inc., Passaic, N. J.

PLASTIC MACHINES [358]
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia, Pa.
Ekstrand & Tholand, Inc., New York
Elmes Engineering Works of American Steel Foundries, Chicago, Ill.
Hydraulic Press Mfg. Co., Mt. Gilead, O.
Kux Machine Co., Chicago
Lake Erie Engr. Corp., Buffalo, N. Y.
Lester Engineering Co., Cleveland
Phoenix Machine Co., Cleveland, Ohio
F. J. Stokes Machine Co., Philadelphia, Pa.

PLATERS' CLEANING COMPOUNDS [359]
Cowles Detergent Co., Cleveland
Crown Rheostat & Supply Co., Chicago
Gilbert Cummins & Co., Baltimore, Md.
Detroit Rex Products Co., Detroit, Mich.
E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Fidelity Chemical Prod. Corp., Newark
E. F. Houghton & Co., Philadelphia, Pa.
Kelite Products, Inc., Los Angeles
W. D. MacDermid Chem. Co., Bristol, Conn.
MacDermid, Inc., Waterbury, Conn.

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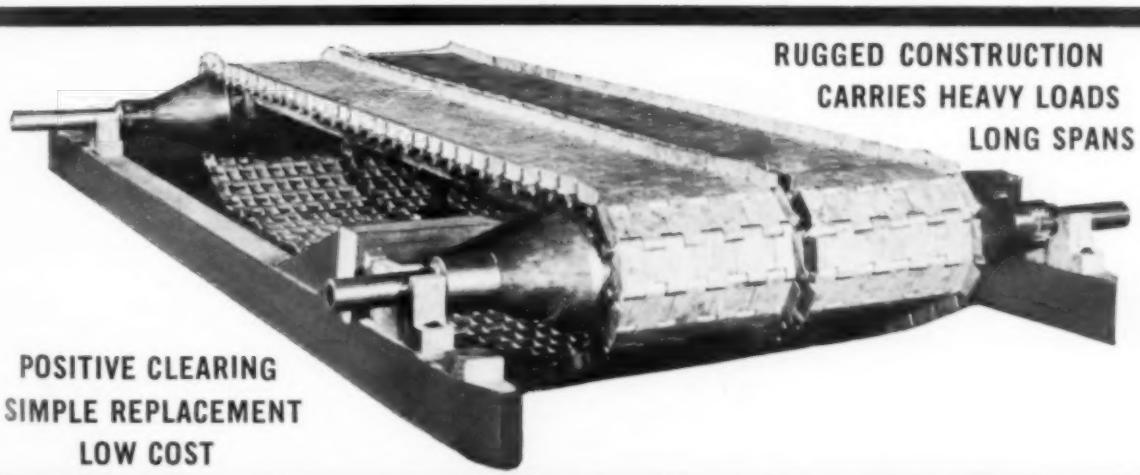

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Magnus Chem. Co., Inc., Garwood, N. J.
Magnuson Prod. Corp., Brooklyn, N. Y.
Oakite Products, Inc., New York
Pennsylvania Salt Mfg. Co., Philadelphia
Philadelphia Quartz Co., Philadelphia
Solventol Chemical Products, Inc., Detroit
Technical Process Div., Colonial Alloys Co., Philadelphia, Pa.

PLATES [360]
Alan Wood Steel Co., Conshohocken, Pa.
Aluminum Co. of America, Pittsburgh, Pa.
American Brass Co., Waterbury, Conn.
Beals-McCarthy & Rogers, Inc., Buffalo
Benedict-Miller, Inc., Newark, N. J.
Bethlehem Steel Co., Bethlehem, Pa.
A. M. Byers Co., Pittsburgh, Pa.
G. O. Carlson, Inc., Thorndale, Pa.
Carnegie-Illinois Steel Corp., Pgh., Pa.
Central Iron & Steel Co., Harrisburg, Pa.
Challenge Mach. Co., Grand Haven, Mich.
Columbia Steel Co., San Francisco, Calif.
Granite City Steel Co., Granite City, Ill.
W. J. Holliday & Co., Hammond, Ind.
Ingersoll Steel & Disc Div., Borg-Warner Corp., New Castle, Ind.
Inland Steel Co., Chicago
Jessop Steel Co., Washington, Pa.
Lukens Steel Co., Coatesville, Pa.
Peninsular Steel Co., Cleveland, O.
Pennsylvania Iron & Steel Co., Los Angeles, Calif.
Republic Steel Corp., Cleveland, Ohio
Revere Copper & Brass Co., New York
Jos. T. Ryerson & Son, Inc., Chicago
Tenn. Coal, Iron & R. R. Co., Birm., Ala.
U. S. Steel Supply Co., Chicago
Univ.-Cyclops Steel Corp., Bridgeville, Pa.

PLATES—Porous [361]
Carborundum Co., Perth Amboy, N. J.
Moraine Products Div., Dayton, O.
National Carbon Co., Inc., Cleveland
National Carbon Co., Inc., New York
Norton Co., Worcester, Mass.
Selas Co., Philadelphia, Pa.

PLATINUM & PLATINUM ALLOYS [362]
Callite Tungsten Corp., Union City, N. J.
Thos. J. Dee & Co., Chicago
Ekstrand & Tholand, Inc., New York
Claud S. Gordon Co., Chicago, Ill.
J. M. Ney Co., Hartford, Conn.
Arklay S. Richards Co., Inc., Newton Highland, Mass.
H. A. Wilson Co., Newark, N. J.

PLATING BASKETS [363]
American Hard Rubber Co., New York
General Alloys Co., Boston, Mass.
MacDermid, Inc., Waterbury, Conn.
Rolock, Inc., Fairfield, Conn.
Stanwood Corp., Chicago
Tate-Jones & Co., Inc., Leetsdale, Pa.
Union Steel Products Co., Albion, Mich.

PLATING EQUIPMENT [364]
Advance Polishing Wheels, Inc., Chicago
Bullard-Dunn Process Div., Bullard Co., Bridgeport, Conn.
Columbia Electric Mfg. Co., Cleveland
Crown Rheostat & Supply Co., Chicago
Duriron Brothers Co., Troy, Ohio
Heil Engineering Co., Cleveland
Chas. F. L'Hommedieu & Sons Co., Chicago
MacDermid, Inc., Waterbury, Conn.
Meaker Co., Chicago, Ill.
N. Ransohoff, Inc., Cincinnati, Ohio
Rapid Electroplating Process, Chicago
Sparkler Mfg. Co., Mundelein, Ill.
Frederic B. Stevens, Inc., Detroit, Mich.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Udylite Corp., Detroit

POLISHING MACHINES [365]
Amer. Instrument Co., Silver Spring, Md.
Amer. Mang. Steel Div., American Brake Shoe Co., Chicago Hts.
A. I. Buehler, Chicago, Ill.
Burrell Technical Supply Co., Pittsburgh
Cincinnati Elec. Tool Co., Cincinnati, O.
Crown Rheostat & Supply Co., Chicago
Divine Brothers Co., Utica, N. Y.
Fisher Scientific Co., Pittsburgh
Hammond Machy. Bldrs., Kalamazoo, Mich.
Hild Floor Machine Co., Chicago, Ill.
Howe & Son, Inc., Hinsdale, N. H.
Tracy C. Jarrett, Catonsville, Md.
Manderscheid Co., Chicago
Production Machine Co., Greenfield, Mass.
George Scherr Co., Inc., New York
Skilsaw, Inc., Chicago
Stow Mfg. Co., Binghamton, N. Y.
Sturgis Prod. Co., Sturgis, Mich.
Sutton Engineering Co., Pittsburgh
Udylite Corp., Detroit

POTENTIOMETERS—See Pyrometers

POTS—Lead, Cyanide [366]
Ajax Electric Co., Inc., Philadelphia
Alloy Casting Co., Champaign, Ill.
Amer. Gas Furnace Co., Elizabeth, N. J.
Amer. Mang. Steel Div., American Brake Shoe Co., Chicago Hts.
Bell & Gossett Co., Morton Grove, Ill.
Bellis Heat Treating Co., Branford, Conn.
Case Hardening Service Co., Cleveland
Chicago Steel Foundry Co., Chicago, Ill.
Driver-Harris Co., Harrison, N. J.
Duraloy Co., Scottdale, Pa.
Eclipse Fuel Engineering Co., Rockford, Ill.
Electric Furnace Co., Salem, Ohio
Electro Alloys Co., Elyria, Ohio
Fahralloy Co., Harvey, Ill.
General Alloys Co., Boston, Mass.
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago, Ill.
Heatbath Corp., Springfield, Mass.
Hevi Duty Elec. Co., Milwaukee
A. F. Holden Co., West Haven, Conn.
Charles A. Hones, Inc., Baldwin, N. Y.
Hoskins Mfg. Co., Detroit, Mich.
Johnson Gas Appl. Co., Cedar Rapids, Ia.
Lebanon Steel Foundry, Lebanon, Pa.
Mahr Manufacturing Co., Minneapolis
Meehanite Research Institute, Pgh., Pa.
Michiana Prod. Corp., Michigan City, Ind.
Michigan Steel Casting Co., Detroit, Mich.
Midvale Co., Nicetown, Philadelphia, Pa.
Morrison Engineering Corp., Cleveland
Ohio Steel Foundry Co., Springfield, Ohio
Park Chemical Co., Detroit, Mich.
Pressed Steel Co., Wilkes-Barre, Pa.
Standard Alloy Co., Cleveland
Sterling Alloys, Inc., Woburn, Mass.
Surface Combustion, Toledo, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.
Harold E. Trent Co., Philadelphia, Pa.
Vulcan Corp., Philadelphia

POWDER METAL EQUIPMENT [367]
Harper Elec. Furnace Corp., Niagara Falls
Howard Engr. & Mfg. Co., Cincinnati
Kux Machine Co., Chicago
Lake Erie Engr. Corp., Buffalo, N. Y.

POWDERED METALS—See Metal Powders

POWDER METALLURGY PRODUCTS Ferrous [368]
Amer. Electro Metal Corp., Yonkers, N. Y.
Callite Tungsten Corp., Union City, N. J.
Chrysler Corp., Amplex Div., Detroit
Ekstrand & Tholand, Inc., New York
Firth-Sterling Steel Co., McKeesport, Pa.
Charles Hardy, Inc., New York, N. Y.
Keystone Carbon Co., St. Marys, Pa.
P. R. Mallory & Co., Inc., Indianapolis
Metal Hydrides, Inc., Beverly, Mass.
Metals Refining Co., Hammond, Ind.
Moraine Products Div., General Motors Corp., Dayton, Ohio
Neveroil Bearing Co., Wakefield, Mass.
Pittsburgh Crushed Steel Co., Pittsburgh
Plastic Metals, Inc., Johnstown, Pa.
Powder Metals & Alloys, Inc., New York
Powder Metallurgy, Inc., Long Island City, N. Y.
U. S. Graphite Co., Saginaw, Mich.

POWDER METALLURGY PRODUCTS Non-Ferrous [369]
Aluminum Co. of America, Pittsburgh, Pa.
Bound Brook Oil-Less Bearing Co., Bound Brook, N. J.
Callite Tungsten Corp., Union City, N. J.
Chrysler Corp., Amplex Div., Detroit
Ekstrand & Tholand, Inc., New York
General Metals Powder Co., Akron, Ohio
Gibson Electric Co., Pittsburgh
Charles Hardy, Inc., New York, N. Y.
Foote Mineral Co., Philadelphia
Johnson Bronze Co., New Castle, Pa.
Keystone Carbon Co., St. Marys, Pa.
Krembs & Co., Chicago
P. R. Mallory & Co., Inc., Indianapolis
Metal Hydrides, Inc., Beverly, Mass.
Metals Refining Co., Hammond, Ind.
Neveroil Bearing Co., Wakefield, Mass.
Powder Metals & Alloys, Inc., New York
Powder Metallurgy, Inc., Long Island City, N. Y.
Reynolds Metals Co., Louisville, Ky.
Speer Carbon Co., St. Marys, Pa.
Tungsten Carbide Tool Co., Detroit, Mich.
U. S. Graphite Co., Saginaw, Mich.
Vascoloy-Ramet Corp., North Chicago
H. A. Wilson Co., Newark, N. J.

PRECIOUS METALS—[370]
Callite Tungsten Corp., Union City, N. J.
Canadian Radium & Uranium Corp., N. Y.
Thomas J. Dee & Co., Chicago
Ekstrand & Tholand, Inc., New York
Handy & Harman, New York
Indium Corp. of America, New York
P. R. Mallory & Co., Inc., Indianapolis
J. M. Ney Co., Hartford, Conn.
Permo Products Corp., Chicago, Ill.
H. A. Wilson Co., Newark, N. J.

PRECISION MEASURING INSTRUMENTS [371]
American Inst. Co., Silver Spring, Md.
American Optical Co., Southbridge, Mass.
F. E. Anderson Oil Co., Portland, Conn.
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia, Pa.
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Brush Development Co., Cleveland, Ohio
Burrell Technical Supply Co., Pittsburgh
Central Scientific Co., Chicago, Ill.
John Chatillon & Sons, New York, N. Y.
W. C. Dillon & Co., Inc., Chicago
Engineers Specialties Div., Cleveland
Engineers Specialties Div., Buffalo
R. Y. Ferner Co., Boston, Mass.
Foxboro Co., Foxboro, Mass.
Gaertner Scientific Corp., Chicago
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago
Leeds & Northrup Co., Philadelphia, Pa.
Millers Falls Co., Greenfield, Mass.
Tinius Olsen Testing Machine Co., Phila.
Pfaltz & Bauer, Inc., New York
Physicists Research Co., Ann Arbor, Mich.
Pyrometer Instr. Co., New York, N. Y.
Arklay S. Richards Co., Inc., Newton Highlands, Mass.
Riehle Testing Machine Div.; American Machine & Metals, Inc., East Moline, Ill.
George Scherr Co., New York, N. Y.
Sheffield Corp., Dayton, Ohio
Size Control Co., Chicago
Tate-Jones & Co., Inc., Leetsdale, Pa.
Testing Machines, Inc., New York
Trico Products Corp., Buffalo, N. Y.
Triplett Elec. Instrument Co., Bluffton, O.
Wheelco Instruments Co., Chicago, Ill.
Wilson Mech. Instr. Co., Inc., New York
Carl Zeiss, Inc., New York

PRESSED METAL PARTS [372]
Aluminum Co., of America, Pittsburgh, Pa.
American Brass Co., Waterbury, Conn.
Amer. Locomotive Co., Schenectady, N. Y.
Bridgeport Brass Co., Bridgeport, Conn.
By-Products Steel Corp., Coatesville, Pa.
Callite Tungsten Corp., Union City, N. J.
Chase Brass & Cop. Co., Waterbury, Conn.
W. C. Dillon & Co., Inc., Chicago
Follansbee Steel Corp., Pittsburgh, Pa.
Charles Hardy, Inc., New York, N. Y.
Hydro Mfg. Co., Detroit, Mich.
Lukens Steel Co., Coatesville, Pa.
Manganese Steel Forge Co., Philadelphia
Moraine Products Div., Dayton, O.
Powder Metals & Alloys, Inc., New York
Pressed Steel Co., Wilkes-Barre, Pa.
Republic Steel Corp., Cleveland
Revere Copper & Brass, Inc., New York
Stanley Works, Pressed Metal Div., New Britain, Conn.
Worcester Pressed Steel Co., Worcester

PRESSES [373]
Amer. Steel Foundries, Chicago, Ill.
Anderson Bros. Mfg. Co, Rockford, Ill.
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia, Pa.
E. W. Bliss Co., Brooklyn, N. Y.
Chambersburg Eng. Co., Chambersb'g, Pa.
Colonial Broach Co., Detroit, Mich.
Elmes Engineering Works of Amer. Steel Foundries, Chicago
Erie Foundry Co., Erie, Pa.
A. B. Farquhar Co., York, Pa.
Ferracute Machine Co., Bridgeton, N. J.
Ford Chain Block Div., American Chain & Cable Co., Philadelphia, Pa.
Greenerd Arbor Press Co., Nashua, N. H.
Hydropress, Inc., New York City
Kux Machine Co., Chicago
Lake Erie Engrg. Corp., Kenmore, N. Y.
Lester Engineering Co., Cleveland, Ohio
Manley Mfg. Div., American Chain & Cable Co., Inc., York, Pa.
Mesta Machine Co., Pittsburgh, Pa.

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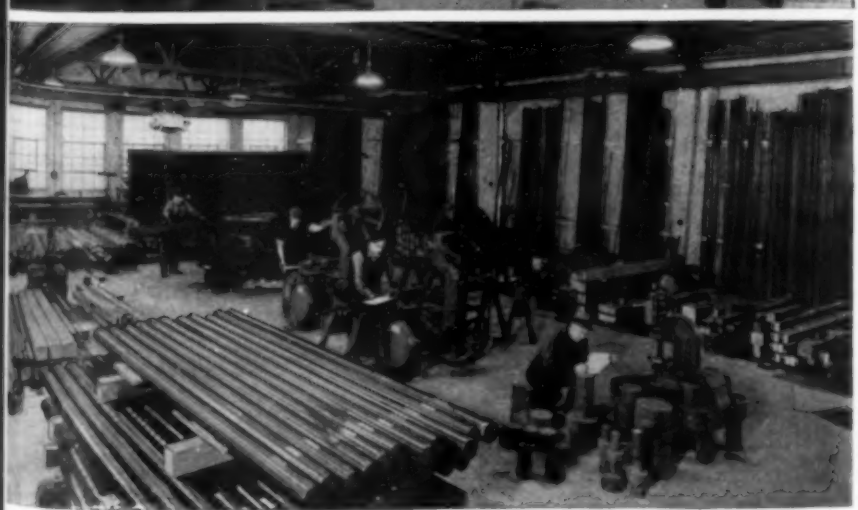

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National Machinery Co., Tiffin, Ohio
Niagara Mach. & Tool Wks., Buffalo
Parsons Engr. Corp., Cleveland, Ohio
Standard Machinery Co., Providence, R. I.
F. J. Stokes Machine Co., Philadelphia, Pa.
Taber Instr. Co., N. Tonawanda, N. Y.
R. D. Wood Co., Philadelphia, Pa.
Wright Mfg. Div., Amer. Chain & Cable Co., York, Penna.

PRESSES—Extrusion [374]
Erie Foundry Co., Erie, Pa.
A. B. Farquhar Co., York, Pa.
Lake Erie Engr. Corp., Buffalo, N. Y.

PRESSESS—Forging and Coining [375]
Ajax Mfg. Co., Cleveland, Ohio
Amer. Steel Foundries, Chicago, Ill.
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia, Pa.
Chambersburg Eng. Co., Chambersb'g, Pa.
Elmes Engineering Works of American Steel Foundries, Chicago, Ill.
Erie Foundry Co., Erie, Pa.
A. B. Farquhar Co., York, Pa.
Ferracute Machine Co., Bridgeton, N. J.
Hydraulic Press Mfg. Co., Mt. Gilead, O.
Hydropress, Inc., New York City
Lake Erie Engrg. Corp., Kenmore, N. Y.
National Machinery Co., Tiffin, Ohio
R. D. Wood Co., Philadelphia, Pa.

PRESSES—Hydraulic [376]
Amer. Steel Foundries, Chicago, Ill.
Anderson Bros. Mfg. Co., Rockford, Ill.
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia, Pa.
Adolph I. Buehler, Chicago, Ill.
Chambersburg Eng. Co., Chambersb'g, Pa.
Colonial Broach Co., Detroit, Mich.
Elmes Engineering Works of American Steel Foundries, Chicago, Ill.
Erie Foundry Co., Erie, Pa.
A. B. Farquhar Co., York, Pa.
Farrel-Birmingham Co., Ansonia, Conn.
Ferracute Machine Co., Bridgeton, N. J.
Fisher Scientific Co., Pittsburgh
Chas. E. Francis Co., Rushville, Ind.
Greenerd Arbor Press Co., Nashua, N. H.
Hannifin Manufacturing Co., Chicago
Hydraulic Press Mfg. Co., Mt. Gilead, O.
Hydropress, Inc., New York City
Tracy C. Jarrett, Catonsville, Md.
Kux Machine Co., Chicago
Lake Erie Engrg. Corp., Kenmore, N. Y.
Mackintosh-Hemphill Co., Pittsburgh, Pa.
Mesta Machine Co., Pittsburgh, Pa.
Parsons Engineering Corp., Cleveland
Precision Scientific Co., Chicago
Service Machine Co., Elizabeth, N. J.
Schloemann Engrg. Corp., Pittsburgh
F. J. Stokes Machine Co., Philadelphia, Pa.
Sutton Engineering Co., Pittsburgh
R. D. Wood Co., Philadelphia, Pa.
Wright Mfg. Div., York, Pa.

PRESSES—Mechanical [377]
Aetna-Standard Engr. Co., Youngstown
E. W. Bliss Co., Brooklyn, N. Y.
Chambersburg Eng. Co., Chambersb'g, Pa.
Cleve. Crane & Engr. Co., Wickliffe, O.
Erie Foundry Co., Erie, Pa.
Ferracute Machine Co., Bridgeton, N. J.
Chas. E. Francis Co., Rushville, Ind.
Greenerd Arbor Press Co., Nashua, N. H.
Kux Machine Co., Chicago
National Machinery Co., Tiffin, Ohio
Niagara Mach. & Tool Wks., Buffalo
Parsons Engineering Corp., Cleveland
Standard Machinery Co., Providence, R. I.
F. J. Stokes Machine Co., Philadelphia, Pa.
Wright Mfg. Div., York, Pa.

PRESSES—Pneumatic [378]
Chamb. Eng. Co., Chambersburg, Pa.
Hannifin Manufacturing Co., Chicago
F. J. Stokes Machine Co., Philadelphia, Pa.

PRESSES—Steam-Hydraulic [379]
Chamb. Eng. Co., Chambersburg, Pa.
Chas. E. Francis Co., Rushville, Ind.
Hydropress, Inc., New York
Lake Erie Engr. Corp., Buffalo, N. Y.

PRESSES—Trimming [380]
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia, Pa.
E. W. Bliss Co., Brooklyn, N. Y.
Chambersburg Eng. Co., Chambersb'g, Pa.
Erie Foundry Co., Erie, Pa.
Ferracute Machine Co., Bridgeton, N. J.
Hydraulic Press Mfg. Co., Mt. Gilead, O.
Lake Erie Engrg. Corp., Kenmore, N. Y.
Ingersoll-Rand Co., Phillipsburg, N. J.
Standard Machinery Co., Providence, R. I.

PUMPS—[381]
Alsop Engineering Corp., Milldale, Conn.
American Hard Rubber Co., New York
Amer. Mang. Steel Div., American Brake Shoe Co., Chicago Hts.
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia, Pa.
Beach Russ Co., New York
Bell & Gossett Co., Morton Grove, Ill.
S. F. Bowser & Co., Inc., Ft. Wayne, Ind.
Case Hardening Service Co., Cleveland
Chain Belt Co., Milwaukee, Wis.
Chamb. Eng. Co., Chambersburg, Pa.
Duriron Co., Inc., Dayton, O.
Elmes Engineering Works of American Steel Foundries, Chicago, Ill.
Fairbanks, Morse & Co., Chicago
Chas. E. Francis Co., Rushville, Ind.
Claud S. Gordon Co., Chicago
Hydro-Power Systems, Inc., Mt. Gilead, O.
Hydropress, Inc., New York
Ingersoll-Rand Co., New York
Jones Motrola Sales Co., Stamford, Conn.
Kinney Manufacturing Co., Boston, Mass.
National Carbon Co., Inc., New York
F. J. Stokes Machine Co., Philadelphia, Pa.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Tri-Clover Machine Co., Kenosha, Wis.
Tuthill Pump Co., Chicago
Vulcan Corp., Philadelphia
Worthington Pump & Machinery Corp., Harrison, N. J.

PUNCHES & DIES [382]
E. W. Bliss Co., Brooklyn, N. Y.
Buffalo Forge Co., Buffalo, N. Y.
Continental Machines, Inc., Minneapolis
Firth-Sterling Steel Co., McKeesport, Pa.
Manley Mfg. Div., American Chain & Cable Co., Inc., York, Pa.
Meehanite Research Institute, Pgh., Pa.
Parker-Kalon Corp., New York
Poulsen & Nardon, Inc., Los Angeles
Pressed Steel Co., Wilkes-Barre, Pa.
Service Machine Co., Elizabeth, N. J.
F. J. Stokes Machine Co., Philadelphia, Pa.
Taft-Peirce Mfg. Co., Woonsocket, R. I.

PUNCHING & SHEARING MACHINES [383]
Buffalo Forge Co., Buffalo, N. Y.
Chamb. Eng. Co., Chambersburg, Pa.
Cont. Roll & Steel Fdry., E. Chicago, Ill.
Lake Erie Engr. Corp., Buffalo, N. Y.
Niagara Mach. & Tool Wks., Buffalo
Parsons Engineering Corp., Cleveland
E. H. Sargent & Co., Chicago
Whiting Corp., Harvey, Ill.

PYROMETER TUBES—Refrac. [384]
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Burrell Technical Supply Co., Pittsburgh
Carborundum Co., Perth Amboy, N. J.
Harry W. Dietert Co., Detroit, Mich.
Driver-Harris Co., Harrison, N. J.
Duraloy Co., Scottdale, Pa.
R. A. Ekstrom, Jr., Co., Harvey, Ill.
Electro Ref. & Alloys Corp., Buffalo
Charles Englehard, Inc., Newark, N. J.
Foxboro Co., Foxboro, Mass.
Claud S. Gordon Co., Chicago, Ill.
Hoskins Mfg. Co., Detroit, Mich.
Illinois Testing Labs., Chicago, Ill.
J-B-T Inst., Inc., New Haven, Conn.
Leeds & Northrup Co., Philadelphia, Pa.
National Carbon Co., Inc., New York
Norton Co., Worcester, Mass.
Pressed Steel Co., Wilkes-Barre, Pa.
Pyrometer Instrument Co., New York City
Arklay S. Richards Co., Inc., Newton Highlands, Mass.
E. H. Sargent & Co., Chicago
C. J. Tagliabue Mfg. Co., Brooklyn, N. Y.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia
Wheelco Instruments Co., Chicago, Ill.

PYROMETERS [385]
Amer. Gas Furnace Co., Elizabeth, N. J.
Bailey Meter Co., Cleveland, Ohio
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Burrell Technical Supply Co., Pittsburgh
Cambridge Instrument Co., Inc., N. Y., N. Y.
Case Hardening Service Co., Cleveland
Central Scientific Co., Chicago, Ill.
Detroit Electric Furnace Div., Kuhlman Electric Co., Bay City, Mich.
Harry W. Dietert Co., Detroit, Mich.
Driver-Harris Co., Harrison, N. J.
Eimer & Amend, New York
R. A. Ekstrom, Jr., Co., Harvey, Ill.
Charles Englehard, Inc., Newark, N. J.
Fisher Scientific Co., Pittsburgh
Foxboro Co., Foxboro, Mass.
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago, Ill.
Hoskins Mfg. Co., Detroit, Mich.
Illinois Testing Lab., Inc., Chicago
J-B-T Instruments, New Haven, Conn.
Leeds & Northrup Co., Philadelphia, Pa.
Pyrometer Instrument Co., New York City
Arklay S. Richards Co., Inc., Newton Highlands, Mass.
C. J. Tagliabue Mfg. Co., Brooklyn, N. Y.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Taylor Instr. Companies, Rochester, N. Y.
Thwing-Albert Instr. Co., Philadelphia
Triplett Elec. Instrument Co., Bluffton, O.
Vulcan Corp., Philadelphia
Wheelco Instruments Co., Chicago, Ill.
Wilkens-Anderson Company, Chicago

QUENCH BASKETS [386]
Alloy Casting Co., Champaign, Ill.
Alloy Mfg. Co., Inc., Pittsburgh, Pa.
Amer. Mang. Steel Div., American Brake Shoe Co., Chicago Hts.
Audubon Wire Cloth Corp., Philadelphia
Bell & Gossett Co., Morton Grove, Ill.
Bellis Heat Treating Co., Branford, Conn.
Chicago Steel Foundry Co., Chicago
Despatch Oven Co., Minneapolis, Minn.
Driver-Harris Co., Harrison, N. J.
Electro Alloys Co., Elyria, Ohio
Fahralloy Co., Harvey, Ill.
General Alloys Co., Boston, Mass.
Claud S. Gordon Co., Chicago, Ill.
A. F. Holden Co., West Haven, Conn.
Hoskins Mfg. Co., Detroit, Mich.
Lansing Engineering Co., Lansing, Mich.
MacDermid, Inc., Waterbury, Conn.
Michiana Prod. Corp., Michigan City, Ind.
Ohio Steel Foundry Co., Springfield, Ohio
G. S. Peterson Co., Cleveland, Ohio
Pressed Steel Co., Wilkes-Barre, Pa.
Rolock, Inc., Fairfield, Conn.
Stanwood Corp., Chicago
Sterling Alloys, Inc., Woburn, Mass.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Union Steel Products Co., Albion, Mich.
Vulcan Corp., Philadelphia
Whitehead Metal Products Co., New York

QUENCH TANK BELTING [387]
Alloy Casting Co., Champaign, Ill.
Audubon Wire Cloth Corp., Philadelphia
G. S. Blakeslee & Co., Chicago
Chicago Steel Foundry Co., Chicago, Ill.
General Alloys Co., Boston, Mass.
Ohio Steel Foundry Co., Springfield, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia

QUENCH TANKS—See Tanks

RADIUM [388]
Canadian Radium & Uranium Corp., N. Y.
Radium Chemical Co., Inc., New York

RECTIFIERS [389]
Allis-Chalmers Mfg. Co., Milwaukee
MacDermid, Inc., Waterbury, Conn.
P. R. Mallory & Co., Inc., Indianapolis

REFRACTORIES [390]
Acme Brick Co., Ft. Worth, Texas
Amer. Crucible Co., Shelton, Conn.
Armstrong Cork Co., Lancaster, Pa.
Babcock & Wilcox Co., New York
Basic Refractories, Inc., Cleveland, Ohio
Bonfield Refractories Co., Philadelphia
Brickseal Refractory Co., Hoboken, N. J.
Carborundum Co., Perth Amboy, N. J.
Chicago Retort & Fire Brick Co., Chicago
Cleveland Quarries Co., Cleveland
Corhart Ref. Co., Inc., Louisville 10, Ky.
Detroit Elec. Furn. Div., Bay City, Mich.
E. I. du Pont de Nemours, Wilmington
Electro Refract. & Alloys Corp., Buffalo
Federal Refractories Corp., Akron, O.
General Electric, Schenectady, N. Y.
General Refractories Co., Philadelphia
Harbison-Walker Refrac. Co., Pgh., Pa.
Ill. Clay Products Co., Joliet, Ill.
Ironton Fire Brick Co., Ironton, O.
Johns-Manville, New York
Laclede-Christy Clay Prod. Co., St. Louis
Lava Crucible Co. of Pittsburgh, Pgh.
McLeod & Henry Co., Inc., Troy, N. Y.
North Amer. Refractories Co., Cleveland
Norton Co., Worcester, Mass.
Plibrico Jointless Firebrick Co., Chicago
Quigley Co., Inc., New York
Ramtite Co., Chicago, Ill.
F. E. Schindler Co., Inc., Long Island City

Atlas Co., Philadelphia, Pa.
Standard Fuel Engineering Co., Detroit
Frederic B. Stevens, Inc., Detroit
Tate-Jones & Co., Inc., Leetsdale, Pa.
Chas. Taylor Sons Co., Cincinnati, O.
Titanium Alloy Mfg. Co., Niagara Falls
Wahl Refractory Prod. Co., Fremont, Ohio

REFRIGERATION—Metal Chilling [391]
American Coils Co., Newark, New Jersey
Amer. Instrument Co., Silver Spring, Md.
Brunner Manufacturing Co., Utica, N. Y.
E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Gold-Hold Mfg. Co., Lansing, Mich.
Revco, Inc., Deerfield, Mich.
Seeden Freezer Mfg. Co., Seattle, Wash.
Tate-Jones & Co., Inc., Leetsdale, Pa.

REGULATORS [392]
Air Reduction, New York
Bailey Meter Co., Cleveland, Ohio
Barber-Colman Co., Rockford, Ill.
Bastian-Blessing Co., Chicago, Ill.
Bristol Co., Waterbury, Conn.
Burling Instrument Co., Newark, N. J.
Chaplin-Fulton Mfg. Co., Pittsburgh, Pa.
C. W. Cramer Co., Inc., Centerbrook, Conn.
Detroit Electric Furnace Div., Kuhlman Electric Co., Bay City, Mich.
Dockson Corp., Detroit, Mich.
Foxboro Co., Foxboro, Mass.
General Controls Co., Glendale, Calif.
General Electric Co., Schenectady, N. Y.
General Welding & Equip. Co., Boston
Harris Calorific Co., Cleveland, Ohio
Hays Corp., Michigan City, Ind.
Linde Air Products Co., New York
Manning, Maxwell & Moore, Inc., Bridgeport, Conn.
Modern Engineering Co., St. Louis, Mo.
North American Mfg. Co., Cleveland
Paasche Airbrush Co., Chicago, Ill.
Partlow Corp., New Hartford, N. Y.
Reading-Pratt & Cady Div., American Chain & Cable Co., Reading, Pa.
Smith Welding Equipment Corp., Minneapolis, Minn.
Sprague Meter Co., Bridgeport, Conn.
T. J. Tagliabue Mfg. Co., Brooklyn, N. Y.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Taylor Instr. Companies, Rochester, N. Y.
Tolman Mfg. Co., Boston, Mass.
Universal Power Corp., Cleveland
Victor Equipment Co., San Francisco
Wheelco Instruments Co., Chicago, Ill.

RESISTORS [393]
Alloy Casting Co., Champaign, Ill.
Carborundum Co., Perth Amboy, N. J.
Cutler-Hammer, Inc., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Leeds & Northrup Co., Philadelphia, Pa.
P. R. Mallory & Co., Indianapolis, Ind.
Ohio Carbon Co., Cleveland, Ohio
Westinghouse Elec. & Mfg. Co., E. Pgh.

RIVET HEATERS [394]
Amer. Car & F'dry Co., New York, N. Y.
Amer. Gas Furnace Co., Elizabeth, N. J.
Chicago Flexible Shaft Co., Chicago
Eclipse Fuel Engineering Co., Rockford, Ill.
Hauck Manufacturing Co., Brooklyn, N. Y.
Johnston Mfg. Co., Minneapolis
Mahr Mfg. Co., Minneapolis
W. S. Rockwell Co., New York
Surface Combustion, Toledo, O.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Universal Power Corp., Cleveland
Vulcan Corp., Philadelphia

RIVET MAKING MACHINES—See Bolt, Nut and Rivet Machinery

RIVETS [395]
Aluminum Co. of America, Pittsburgh, Pa.
American Bridge Co., Pittsburgh, Pa.
American Steel & Wire, Cleveland, Ohio
Bethlehem Steel Co., Bethlehem, Pa.
Cullite Tungsten Corp., Union City, N. J.
Carnegie-Illinois Steel Corp., Pittsburgh
Chase Brass & Cop. Co., Waterbury, Conn.
Cherry Rivet Co., Los Angeles
Chicago Rivet & Machine Co., Chicago
Clark Bros. Bolt Co., Millidale, Conn.
Columbia Steel Co., San Francisco, Calif.
Driver-Harris Co., Harrison, N. J.
Jamson & Sessions Co., Cleveland
Milford Rivet & Mach. Co., Milford, Conn.
Republic Steel Corp., Cleveland, Ohio
A. T. Ryerson & Son, Inc., Chicago
Tenn. Coal, Iron & R. R. Co., Birm., Ala.
U. S. Steel Supply Co., Chicago
Whitehead Metal Products Co., New York

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IngAclad (Stainless-Clad Steel)
Stainless Steels and Saw Steels, including "18-4-1" and Molybdenum and D-B-L Hack Saw Steels

IVETS—Aluminum [396]
luminum Co. of America, Pittsburgh, Pa.
allite Tungsten Corp., Union City, N. J.
herry Rivet Co., Los Angeles
hicago Rivet & Machine Co., Chicago
ark Bros. Bolt Co., Milldale, Conn.
ilford Rivet & Mach, Co., Milford, Conn.
reden Freezer Mfg. Co., Seattle, Wash.
hitehead Metal Products Co., New York

OCKWELL HARDNESS TESTERS—See Hardness Testers

OD BAKERS [397]
arl-Mayer Corp., Cleveland
arrison Engineering Co., Cleveland
. S. Rockwell Co., New York
. O. Ross Engineering Corp., New York
ulcan Corp., **Philadelphia**

ODS—Ferrous [398]
merican Steel & Wire, Cleveland, Ohio
enedict-Miller, Inc., Newark, N. J.
arnegie-Illinois Steel Corp., Pgh. Pa.
arpenter Steel Co., Reading, Pa.
olumbia Steel Co., San Francisco, Calif.
elloy Metals, Philadelphia
river-Harris Co., Harrison, N. J.
arnischfeger Corp., Milwaukee, Wis.
. J. Holliday & Co., Hammond, Ind.
land Steel Co., Chicago
inde Air Products Co., New York
ational Cylinder Gas Co., Chicago
age Steel & Wire Div., American Chain & Cable Co., Monessen, Pa.
ittsburgh Steel Co., Pittsburgh
epublic Steel Corp., Cleveland
eynolds Metals Co., Louisville, Ky.
ham. Coal, Iron & R. R. Co., Birm., Ala.
aken Roller Bearing Co., Canton, O.
. S. Steel Supply Co., Chicago
oungstown Sheet & Tube Co., Youngstown, O.

ODS—Hard Facing [399]
ir Reduction, New York
mer. Agile Corp., Cleveland
mer. Mang. Steel Div., American Brake Shoe Co., Chicago Hts.
allite Tungsten Corp., Union City, N. J.
elloy Metals, Philadelphia, Pa.
arnischfeger Corp., Milwaukee, Wis.
aynes Stellite Co., Kokomo, Ind.
. J. Holliday & Co., Hammond, Ind.
obbs & Co., Chicago
incoln Electric Co., Cleveland, Ohio
inde Air Products Co., New York
IcCauley Alloy Co., Chicago Hts., Ill.
ational Cylinder Gas Co., Chicago
age Steel & Wire Div., American Chain & Cable Co., Monessen, Pa.
arace T. Potts Co., Philadelphia
m. T. Ryerson & Son, Chicago
ody Co., Whittier, Cal.
niversal Power Corp., Cleveland
all-Colmonoy Corp., Detroit

ODS—Non-Ferrous [400]
luminum Co. of America, Pittsburgh, Pa.
merican Brass Co., Waterbury, Conn.
mer. Manganese Bronze Co., Phila., Pa.
mpco Metal, Inc., Milwaukee, Wis.
arium Metals Corp., Rochester, N. Y.
eryllium Corp. of Penn., Reading, Pa.
ridgeport Brass Co., Bridgeport, Conn.
unning Brass & Bronze Co., Toledo, O.
hase Brass & Cop. Co., Waterbury, Conn.
elloy Meals, Philadelphia, Pa.
andy & Harman, New York
aynes Stellite Co., Kokomo, Ind.
nternational Nickel Co., New York
incoln Electric Co., Cleveland, Ohio
inde Air Products Co., New York
. R. Mallory & Co., Indianapolis, Ind.
ational Cylinder Gas Co., Chicago
eralumin Co., Wilmington, Delaware
age Steel & Wire Div., American Chain & Cable Co., Monessen, Pa.
evere Copper & Brass Co., New York
eynolds Metals Co., Louisville, Ky.
iverside Metal Co., Riverside, N. J.
ovill Mfg. Co., Waterbury, Conn.
ran Metal Mfg. Co., Bellefonte, Pa.
hitehead Metal Products Co., New York

ODS—Welding [401]
ir Reduction, New York
oy Casting Co., Champaign, Ill.
oy Rods Co., York, Pa.
luminum Co. of America, Pittsburgh
merican Brass Co., Waterbury, Conn.
mer. Mang. Steel Div., American Brake Shoe Co., Chicago Hts.
merican Steel & Wire, Cleveland, Ohio
Ampco Metal, Inc., Milwaukee, Wis.
Arcos Corp., Philadelphia, Pa.
Benedict-Miller, Inc., Newark, N. J.
Bethlehem Steel Co., Bethlehem, Pa.
Bridgeport Brass Co., Bridgeport, Conn.
Burgess-Parr Co., Freeport, Ill.
Callite Tungsten Corp., Union City, N. J.
Chase Brass & Cop. Co., Waterbury, Conn.
Crucible Steel Co. of America, New York
Thomas J. Dee Co., Chicago
Wilbur B. Driver Co., Newark, N. J.
Driver-Harris Co., Harrison, N. J.
Eutectic Welding Alloys, Inc., New York
Harnischfeger Corp., Milwaukee, Wis.
Haynes Stellite Co., Kokomo, Ind.
Hobart Brothers Co., Troy, Ohio
W. J. Holliday & Co., Hammond, Ind.
Hoskins Mfg. Co., Detroit
International Nickel Co., Inc., N. Y. City
Krembs & Co., Chicago
Lincoln Electric Co., Cleveland, Ohio
Linde Air Products Co., New York
Manganese Steel Forge Co., Philadelphia
Marquette Mfg. Co., Minneapolis, Minn.
Maurath, Inc., Cleveland, O.
McKay Co., Pittsburgh
Metal & Thermit Corp., New York
Mueller Brass Co., Port Huron, Mich.
National Carbon Co., Inc., Cleveland
National Cylinder Gas Co., Chicago
Ohio Carbon Co., Cleveland
Page Steel & Wire Div., American Chain & Cable Co., Monessen, Pa.
Pittsburgh Steel Co., Pittsburgh
Revere Copper & Brass Co., New York
Riverside Metal Co., Riverside, N. J.
Jos. T. Ryerson & Son, Inc., Chicago
Stoody Co., Whittier, Cal.
Taylor-Wharton Iron & Steel Co., High Bridge, N. J.
Titan Metal Mfg. Co., Bellefonte, Pa.
Tolman Mfg. Co., Boston, Mass.
U. S. Steel Supply Co., Chicago
Universal Power Corp., Cleveland
Victor Equipment Co., San Francisco
Wall-Colmonoy Corp., Detroit
Welding Sales & Eng. Co., Detroit
Westinghouse Electric & Mfg. Co., E. Pgh.
Whitehead Metal Products Co., New York
Wickwire Spencer Steel Co., New York
Youngstown Sheet & Tube Co., Youngstown, O.

ROLLS [402]
American Brass Co., Waterbury, Conn.
American Shear Knife Co., Homestead, Pa.
Bethlehem Steel Co., Bethlehem, Pa.
Blaw-Knox Co., Pittsburgh, Pa.
Carpenter Steel Co., Reading, Pa.
Cont. Roll & Steel Fdry., E. Chicago, Ill.
Farrel-Birmingham Co., Ansonia, Conn.
Heppenstall Co., Pittsburgh
Hydropress, Inc., New York
Mackintosh-Hemphill Co., Pittsburgh, Pa.
Manhattan Rubber Mfg. Div., Raybestos-Manhattan, Inc., Passaic, N. J.
Michigan Steel Casting Co., Detroit
Midvale Co., Philadelphia, Pa.
National Forge & Ordnance Co., Irvine, Warren County, Pa.
Ohio Steel Foundry Co., Springfield, Ohio
Parsons Engineering Corp., Cleveland
Revere Copper & Brass Co., New York
Sutton Engineering Co., Pittsburgh
Yoder Co., Cleveland, O.
Youngstown Alloy Cstg. Co., Youngstown
Youngstown Foundry and Machine Co., Youngstown, O.

RUST PREVENTIVES [403]
Alox Corp., Niagara Falls, N. Y.
F. E. Anderson Oil Co., Portland, Conn.
Char Products Co., Indianapolis, Ind.
Farrar Indust. Prod. Co., Los Angeles, Cal.
Fidelity Chemical Prod. Corp., Newark
Fiske Bros. Refining Co., Newark, N. J.
Frost Paint and Oil Corp., Minneapolis, Minn.
Glyco Products Co., Inc., Brooklyn, N. Y.
Heatbath Corp., Springfield, Mass.
E. F. Houghton & Co., Philadelphia
S. C. Johnson & Son, Inc., Racine, Wis.
Kelite Products, Inc., Los Angeles
J. W. Kelley Co., Cleveland
Keystone Lubricating Co., Philadelphia
Krembs & Co., Chicago
MacDermid, Inc., Waterbury, Conn.
Metalloy Products Co., Los Angeles, Calif.
Mitchell-Bradford Chemical Co., Bridgeport, Conn.
Mutual Chem. Co of America, New York
Oakite Products, Inc., New York
Pennsylvania Salt Mfg. Co., Philadelphia
Philadelphia Quartz Co., Philadelphia
Phillips Mfg. Co., Chicago
Protective Coatings, Inc., Detroit
Pyrometer Instrument Co., New York
Quaker Chem. Products Corp., Conshohocken, Pa.
Rex Oil & Chemical Co., Cleveland
Shell Oil Co., New York
Simoniz Co., Chicago
Socony Vacuum Oil Co., New York
Solventol Chemical Products, Inc., Detroit
Standard Oil Co., (Ind.), Chicago
Turco Products, Inc., Los Angeles, Calif.
United Industrial Products, Inc., Elizabeth, N. J.
U. S. Stoneware Co., Akron, Ohio
Warren Ref. & Chem. Co., Cleveland

RUST PROOFING COMPOUNDS [404]
Alox Corp., Niagara Falls, N. Y.
Alrose Chemical Co., Providence, R. I.
Char Products Co., Indianapolis, Ind.
E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Fidelity Chemical Prod. Corp., Newark
Heatbath Corp., Springfield, Mass.
E. F. Houghton & Co., Philadelphia, Pa.
S. C. Johnson & Son, Inc., Racine, Wis.
Kelite Products, Inc., Los Angeles
MacDermid, Inc., Waterbury, Conn.
Magnuson Products Corp., Brooklyn, N. Y.
Metalloy Products Co., Los Angeles, Calif.
Mitchell-Bradford Chemical Co., Bridgeport, Conn.
Parker Rust-Proof Co., Detroit
Philadelphia Quartz Co., Philadelphia
Protective Coatings, Inc., Detroit
Pyrometer Instrument Co., New York
Rex Oil & Chemical Co., Cleveland
Swan Finch Oil Corp., New York
Turco Products, Inc., Los Angeles, Calif.
Warren Ref. & Chem. Co., Cleveland

RUST PROOFING PROCESS [405]
Alrose Chemical Co., Providence, R. I.
American Hot Dip Galvanizers Assn., Inc., Pittsburgh, Pa.
Apollo Metal Works, Chicago
E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Heatbath Corp., Springfield, Mass.
Kelite Products, Inc., Los Angeles
MacDermid, Inc., Waterbury, Conn.
Metalloy Products Co., Los Angeles, Calif.
Mitchell-Bradford Chemical Co., Bridgeport, Conn.
Parker Rust Proof Co., Detroit
Protective Coatings, Inc., Detroit
Udylite Corp., Detroit

RUST PROOFING SYSTEMS [406]
Alvey-Ferguson Co., Cincinnati, O.
Heatbath Corporation, Springfield, Mass.
MacDermid, Inc., Waterbury, Conn.
Phillips Manufacturing Co., Chicago
Metalloy Products Co., Los Angeles, Calif.

SALTS—Coloring & Tempering [407]
Alrose Chemical Co., Providence, R. I.
E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.
Foote Mineral Co., Philadelphia
E. F. Houghton & Co., Philadelphia
J. W. Kelley Co., Cleveland
Mitchell-Bradford Chemical Co., Bridgeport, Conn.
Tate-Jones & Co., Inc., Leetsdale, Pa.

SALTS—Heat Treating [408]
Amer. Cyanamid & Chem. Corp., New York
Bell & Gossett Co., Morton Grove, Ill.
Bellis Heat Treating Co., Branford, Conn.
Case Hardening Service Co., Cleveland
Chicago Flexible Shaft Co., Chicago
E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.
Farrar Indust. Prod. Co., Los Angeles, Cal.
Foote Mineral Co., Philadelphia
Claud S. Gordon Co., Chicago
Heatbath Corp., Springfield, Mass.
A. F. Holden Co., New Haven, Conn.
E. F. Houghton & Co., Philadelphia, Pa.
Macomb Steel Treating Co., Detroit
Mitchell-Bradford Chem. Co., Bridgeport, Conn.
Park Chemical Co., Detroit, Mich.
G. S. Rogers & Co., Chicago, Ill.
Steel Treating Equip. Co., Detroit
D. A. Stuart Oil Co., Ltd., Chicago
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia

SAND BLAST EQUIPMENT [409]
Amer. F'dry Equip. Co., Michawaka, Ind.
Amer. Optical Co., Southbridge, Mass.

Controlled Atmosphere

FOR QUALITY AND UNIFORMITY

Because war production increases the demands for better control in the heat-treating process, Holcroft Furnaces are finding a far wider use today than ever before. Holcroft now offers six general classes of furnaces, using controlled atmospheres—

1. Clean or bright annealing furnaces.
2. Short cycle malleable annealing furnaces.
3. Clean hardening, non-decarburizing furnaces.
4. Light case carburizing furnaces.
5. Carbo-Nitriding furnaces.
6. Deep case carburizing furnaces.

HOLCROFT *does it better*

Just as Holcroft helped pioneer the development of *Controlled Atmosphere*, it now offers its wider, more valuable experience in helping meet the strict specifications of war production.

HOLCROFT AND COMPANY

6545 Epworth Blvd. Detroit, Mich.

Chicago—C. H. Martin, 1355 Peoples Gas Bldg.

Canada—Walker Metal Products, Ltd. Walkerville, Ont.

Dreisbach Engr. Corp., Yonkers, N. Y.
Macleod Co., Cincinnati, Ohio
Manhattan Rubber Mfg. Div., Raybestos-Manhattan Inc., Passaic, N. J.
Metallizing Engr. Co., L. I. City, N. Y.
Pangborn Corp., Hagerstown, Md.
Parsons Engr. Corp., Cleveland, Ohio
Ruemelin Mfg. Co., Milwaukee, Wis.
Sellstrom Mfg. Co., Chicago, Ill.
Tabor Manufacturing Co., Philadelphia
W. W. Sly Mfg. Co., Cleveland, Ohio

SAND BLAST HELMETS [410]
Amer. Fdry. Equip. Co., Mishawaka, Ind.
Amer. Optical Co., Southbridge, Mass.
Chicago Eye Shield Co., Chicago, Ill.
Davis Emergency Equip. Co., Newark, N. J.
Mine Safety Appliances Co., Pittsburgh
Pangborn Corp., Hagerstown, Md.
Parsons Engr. Corp., Cleveland, Ohio
Ruemelin Mfg. Co., Milwaukee, Wis.
Sellstrom Mfg. Co., Chicago, Ill.
W. W. Sly Mfg. Co., Cleveland, Ohio
Willson Products, Inc., Reading, Pa.

SAND BLAST STEEL SHOT—See Abrasives

SAND TESTING EQUIPMENT [411]
Harry W. Dietert Co., Detroit, Mich.

SAWS—Band, Hack for Metal [412]
E. C. Atkins & Co., Indianapolis, Ind.
Beals-McCarthy & Rogers, Inc., Buffalo
Brown-Wales Co., Boston, Mass.
Clemson Bros. Inc., Middletown, N. Y.
Continental Machines, Inc., Minneapolis
Henry Disston & Sons, Inc., Phila., Pa.
DoAll Co., Inc., Des Plaines, Ill.
Grob Bros., Grafton, Wis.
Heller Machine Co., New York, N. Y.
Johnson Mfg. Corp., New York
Jos. T. Ryerson & Son, Inc., Chicago
Simonds Saw & Steel, Fitchburg, Mass.
L. S. Starrett Co., Athol, Mass.
Sweden Freezer Mfg. Co., Seattle, Wash.
Henry G. Thompson & Son Co., New Haven, Conn.
Victor Saw Works, Inc., Middletown, N. Y.
Wells Mfg. Corp., Three Rivers, Mich.

SAWS—Hack Saw Blades [413]
E. C. Atkins & Co., Indianapolis, Ind.
Beals-McCarthy & Rogers, Inc., Buffalo
Benedict-Miller, Inc., Newark, N. J.
Brown-Wales Co., Boston, Mass.
Chase Brass & Cop. Co., Waterbury, Conn.
Clemson Bros., Inc., Middletown, N. Y.
Clipper Manufacturing Co., St. Louis, Mo.
Henry Disston Cons, Inc., Phila., Pa.
Heller Machine Co., New York, N. Y.
W. J. Holliday & Co., Hammond, Ind.
Millers Falls Co., Greenfield, Mass.
Simonds Saw & Steel, Fitchburg, Mass.
L. S. Starrett Co., Athol, Mass.
Henry G. Thompson & Son Co., New Haven, Conn.
Victor Saw Works, Inc., Middletown, N. Y.

SAWS—Metal Cutting [414]
E. C. Atkins & Co., Indianapolis, Ind.
Bethlehem Steel Co., Bethlehem, Pa.
Continental Machines, Inc., Minneapolis
Henry Disston & Sons, Inc., Philadelphia
Heller Machine Co., New York, N. Y.
Sweden Freezer Mfg. Co., Seattle, Wash.
Tabor Manufacturing Co., Philadelphia
Henry G. Thompson & Son Co., New Haven, Conn.
Victor Saw Works, Inc., Middletown, N. Y.
Wells Mfg. Corp., Three Rivers, Mich.

SAWS—Slotting [415]
E. C. Atkins & Co., Indianapolis, Ind.
Henry Disston & Sons, Inc., Phila., Pa.
R. Y. Ferner Co., Boston, Mass.
Genesee Tool Co., Fenton, Mich.
Heller Machine Co., New York, N. Y.
Martindale Electric Co., Cleveland
Simonds Saw & Steel, Fitchburg, Mass.

SCALES—Industrial [416]
John Chatillon & Sons, New York
Detecto Scales, Inc., Brooklyn
Fairbanks, Morse & Co., Chicago
Richardson Scale Co., Clifton, N. J.
Toledo Scale Co., Toledo, Ohio

SCLEROSCOPES—See Hardness Testers

SCREENS—Vibrator [417]
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Jeffrey Mfg. Co., Columbus, Ohio
Link-Belt Co., Philadelphia
Mahr Manufacturing Co., Minneapolis
Newark Wire Cloth Co., Newark, N. J.
Stephens-Adamson Mfg. Co., Aurora, Ill.

SCREENS—Woven Wire [418]
Audubon Wire Cloth Corp., Philadelphia
C. O. Bartlett & Snow Co., Cleveland
Chase Brass & Cop. Co., Waterbury, Conn.
Cyclone Fence Div., Amer. Steel & Wire Co., Waukegan, Ill.
Hoskins Mfg. Co., Detroit, Mich.
Ingersoll Steel & Disc, Chicago
Logan Co., Louisville, Ky.
Ludlow-Saylor Wire Co., St. Louis
Manganese Steel Forge Co., Philadelphia
Newark Wire Cloth Co., Newark, N. J.
Pittsburgh Steel Co., Pittsburgh, Pa.
Rolock, Inc., Fairfield, Conn.
Union Steel Products Co., Albion, Mich.
Whitehead Metal Products Co., New York
Wickwire Brothers, Inc., Cortland, N. Y.
Wickwire Spencer Steel Co., New York

SEPARATORS—Magnetic [419]
Dings Magnetic Separator Co., Milwaukee
MacDermid, Inc., Waterbury, Conn.
Stearns Magnetic Mfg. Co., Milwaukee

SHAFTING—See Bars—Cold Drawn

SHAPE CUTTING MACHINES—Oxy-Acetylene [420]
Air Reduction, New York
Harris Calorific Co., Cleveland, Ohio
Linde Air Products Co., New York
National Cylinder Gas Co., Chicago, Ill.
Universal Power Co., Cleveland

SHEAR BLADES & KNIVES [421]
Acme Machinery Division, The Hill Acme Co., Cleveland
E. C. Atkins & Co., Indianapolis, Ind.
Bethlehem Steel Co., Bethlehem, Pa.
Braeburn Alloy St. Corp., Braeburn, Pa.
Henry Disston & Sons, Inc., Phila., Pa.
Heppenstall Co., Pittsburgh, Pa.
International Nickel Co., New York
Niagara Mach. & Tool Wks., Buffalo
Simonds Saw & Steel Co., Fitchburg, Mass.
Univ-Cyclops Steel Corp., Bridgeville, Pa.
Wapakoneta Machine Co., Wapakoneta, O.

SHEETS [422]
Alan Wood Steel Co., Conshohocken, Pa.
Aluminum Co. of America, Pittsburgh, Pa.
American Brass Co., Waterbury, Conn.
American Rolling Mill Co., Middletown, O.
American Steel & Wire, Cleveland, O.
Apollo Metal Works, Chicago
Apollo Steel Co., Apollo, Pa.
Beals-McCarthy & Rogers, Inc., Buffalo
Bethlehem Steel Co., Bethlehem, Pa.
A. M. Byers Co., Pittsburgh
Carnegie-Illinois Steel Corp., Pgh., Pa.
Chase Brass & Cop. Co., Waterbury, Conn.
Columbia Steel Co., San Francisco, Calif.
Continental Steel Corp., Kokomo, Ind.
Crucible Steel Co. of America, New York
Driver-Harris Co., Harrison, N. J.
Peter A. Frasse & Co., Inc., New York
Follansbee Steel Corp., Pittsburgh, Pa.
Great Lakes Steel Corp., Detroit, Mich.
Haynes Stellite Co., Kokomo, Ind.
Hill-Chase & Co., Philadelphia
W. J. Holliday & Co., Hammond, Ind.
Ingersoll Steel & Disc Div., Borg-Warner Corp., New Castle, Ind.
Inland Steel Co., Chicago
International Nickel Co., New York
Lukens Steel Co., Coatesville, Pa.
National Steel Corp., Pittsburgh, Pa.
Republic Steel Corp., Cleveland, Ohio
Revere Copper & Brass Co., New York
Jos. T. Ryerson & Son, Inc., Chicago
Superior Steel Corp., Carnegie, Pa.
Tenn. Coal, Iron & R. R. Co., Birm., Ala.
U. S. Steel Supply Co., Chicago
Edgar T. Ward's Sons Co., Pittsburgh
Weirton Steel Co., Weirton, W. Va.
Whitehead Metal Products Co., New York

SHEETS—Aluminum [423]
Allegheny Ludlum Steel Co., Brackenridge, Pa.
Aluminum Co. of America, Pittsburgh, Pa.
Fairmont Aluminum Co., Fairmont, W. Va.
Reynolds Metals Co., Louisville, Ky.
Whitehead Metal Products Co., New York

SHEETS—Brass, Bronze or Copper [424]
American Brass Co., Waterbury, Conn.
Amer. Magnesium Corp., Pittsburgh, Pa.
Ampco Metal, Inc., Milwaukee, Wis.
Chase Brass & Cop. Co., Waterbury, Conn.
Riverside Metal Co., Riverside, N. J.
Whitehead Metal Products Co., New York

SHEETS—Magnesium [425]
Aluminum Co. of America, Pittsburgh, Pa.
Dow Chemical Co., Midland, Mich.

SHEETS—Stainless [426]
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Aluminum Co. of America, Pittsburgh, Pa.
Amer. Rolling Mill Co., Middletown, O.
American Steel & Wire Co., Cleveland
Carnegie-Illinois Steel Corp., Pittsburgh
J. O. Carlson, Inc., Thorndale, Pa.
Columbia Steel Co., San Francisco, Calif.
Peter A. Frasse & Co., New York
General Alloys Co., Boston, Mass.
Ingersoll Steel & Disc Div., Borg-Warner Corp., New Castle, Ind.
Republic Steel Corp., Cleveland, Ohio
Jos. T. Ryerson & Son, Inc., Chicago
Superior Steel Corp., Carnegie, Pa.
U. S. Steel Supply Co., Chicago
Vasr-Cyclops Steel Corp., Bridgeville, Pa.
Edgar T. Ward's Sons Co., Pittsburgh

SHEETS—Zinc [427]
E. I. du Pont de Nemours, Wilmington
New Jersey Zinc Co., New York

SHOP MICROSCOPES [428]
Amer. Instrument Co., Silver Spring, Md.
Bausch & Lomb Opt. Co., Rochester, N. Y.
A. I. Buehler, Chicago, Ill.
Burrell Technical Supply Co., Pittsburgh
Central Scientific Co., Chicago, Ill.
Harry W. Dietert Co., Detroit, Mich.
Eberbach & Son Co., Ann Arbor, Mich.
Gaertner Scientific Corp., Chicago
Chas. S. Gordon Co., Chicago, Ill.
E. H. Sargent & Co., Chicago, Ill.
Wilkens-Anderson Company, Chicago
Carl Zeiss, Inc., New York

SILICA REFRACTORIES [429]
Cleveland Quarries Co., Cleveland
General Refractories Co., Philadelphia
Chas. S. Gordon Co., Chicago, Ill.
Harbison-Walker Refrac. Co., Pittsburgh
Johns-Manville, New York
North American Ref. Co., Cleveland
Vale-Jones & Co., Inc., Leetsdale, Pa.
Thos. Taylor Sons Co., Cincinnati, Ohio

SILICON METAL & ALLOYS [430]
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
American Brass Co., Waterbury, Conn.
Anderson & Sons, Westfield, Mass.
Bridgeport Brass Co., Bridgeport, Conn.
Chromium Mining & Smelting Corp., Montreal, Canada
Electro Metallurgical Co., New York
Foote Mineral Co., Philadelphia, Pa.
Metallurgical Products Co., Philadelphia
Miller & Co., Chicago
Niagara Falls Smelting & Refining Corp., Buffalo, N. Y.
Ohio Ferro Alloys Corp., Canton, Ohio
Pittsburgh Metallurgical Co., Niagara Falls, N. Y.
Revere Copper & Brass Co., New York
Vanadium Corp. of America, New York

SILVER AND SILVER ALLOYS [431]
Callite Tungsten Corp., Union City, N. J.
Thomas J. Dee & Co., Chicago
Wilbur B. Driver Co., Newark, N. J.
Eutectic Welding Alloys, Inc., N. Y., N. Y.
Gibson Elec. Co., Pittsburgh
Handy & Harman, New York
Krembs & Co., Chicago
P. R. Mallory & Co., Indianapolis, Ind.
Metallurgical Products Co., Philadelphia
J. M. Ney Co., Hartford, Conn.
U. S. Smelting, Refining & Mining Co., New York
H. A. Wilson Co., Newark, N. J.

SOAKING PITS [432]
Bloomfield Industries, Inc., Pittsburgh, Pa.
Continental Industrial Engineers, Chicago
Electric Furnace Co., Salem, Ohio
Fuel & Dreffein Co., Chicago, Ill.
Salem Engineering Co., Salem, Ohio
Surface Combustion, Toledo, Ohio
Vale-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia
Wales-Strippit Corp., N. Tonawanda, N. Y.

SODA ASH [433]
Amer. Cyan. & Chem., Corp., New York
E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.
Mathieson Alkali Works, Inc., New York
Monsanto Chemical Co., St. Louis, Mo.
Park Chemical Co., Detroit, Mich.
Pennsylvania Salt Mfg. Co., Philadelphia
Pittsburgh Plate Glass Co., Columbia Chemical Div., Pittsburgh

SOLDER [434]
Aluminum Co. of America, Pittsburgh, Pa.
Bohn Aluminum & Brass Co., Detroit
Chase Brass & Cop. Co., Waterbury, Conn.
Colonial Alloys Co., Philadelphia, Pa.
Duquesne Smelting Corp., Pittsburgh
Eagle-Picher Sales Co., Cincinnati, O.
Eutectic Welding Alloys, Inc., N. Y., N. Y.
Kester Solder Co., Chicago, Ill.
Metalloy Products Co., Los Angeles, Calif.
Mueller Brass Co., Port Huron, Mich.
National Lead Co., New York
U. S. Steel Supply Co., Chicago
Whitehead Metal Products Co., New York

SOLDER POWDERS [435]
Amer. Solder & Flux Co., Philadelphia
Eutectic Welding Alloys, Inc., N. Y., N. Y.
Indium Corp. of America, New York
Metals Disintegrating Co., Elizabeth, N. J.
National Cylinder Gas Co., Chicago
Suflo, Inc., Elizabeth, N. J.

SOLDER—Silver [436]
E. C. Atkins & Co., Indianapolis, Ind.
Chase Brass & Cop. Co., Waterbury, Conn.
Thomas J. Dee & Co., Chicago
Duquesne Smelting Corp., Pittsburgh
Eutectic Welding Alloys, Inc., N. Y., N. Y.
Handy & Harman, New York
Krembs & Co., Chicago, Ill.
P. R. Mallory & Co., Inc., Indianapolis
National Cylinder Gas Co., Chicago, Ill.
J. M. Ney Co., Hartford, Conn.
Salem Engineering, Salem, Ohio
Universal Power Corp., Cleveland
Westinghouse Elec. & Mfg. Co., E. Pgh.
Whitehead Metal Products Co., New York
H. A. Wilson Co., Newark, N. J.

IRON POWDER

- For powder metallurgy
- For electronics
- For chemistry
- For any application requiring purity, uniformity, density, or compressibility.

PLAST-IRON, produced electrolytically, is noted for its high purity and unusual physical and electrical properties.

PLAST-SPONGE, a high quality reduced oxide powder, was developed specially for applications demanding large tonnages and low cost.

PLASTIC METALS, INC.

129 Bridge Street
JOHNSTOWN, PENNA.

SOLVENTS [437]
F. E. Anderson Oil Co., Portland, Conn.
G. S. Blakeslee & Co., Chicago, Ill.
Carbide & Carbon Chemicals Corp., New York
Char Products Co., Indianapolis, Ind.
Circo Products Co., Cleveland
Colonial Alloys Co., Philadelphia
Detrex Corp., Detroit
E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.
Fidelity Chemical Prod. Corp., Newark
Frederick Gumm Chem. Co., Kearny, N. J.
Kelite Products, Inc., Los Angeles
Koppers Co., Pittsburgh
MacDermid, Inc., Waterbury, Conn.
Mercury Chemical Co., Inc., Detroit
Monsanto Chemical Co., St. Louis, Mo.
Park Chemical Co., Detroit
Rex Oil & Chemical Co., Cleveland
Solventol Chemical Products, Inc., Detroit
Sun Oil Co., Philadelphia, Pa.

SPECTROGRAPHIC EQUIP. [438]
Bausch & Lomb Opt. Co., Rochester, N. Y.
A. I. Buehler, Chicago, Ill.
Burrell Technical Supply Co., Pittsburgh
Central Scientific Co., Chicago, Ill.
Harry W. Dietert Co., Detroit, Mich.
Eberbach & Son Co., Ann Arbor, Mich.
Gaertner Scientific Corp., Chicago
General Electric X-Ray Corp., Chicago
Leeds & Northrup Co., Philadelphia, Pa.
National Carbon Co., Inc., New York
Rex Oil & Chemical Co., Cleveland
E. H. Sargent & Co., Chicago
Speer Carbon Co., St. Marys, Pa.
Wilkens-Anderson Co., Chicago
Carl Zeiss, Inc., New York

SPEED REDUCERS [439]
Amer. Pulley Co., Philadelphia, Pa.
Farrel-Birmingham Co., Ansonia, Conn.
Foote Bros. Gear & Mach. Corp., Chicago
General Electric Co., Schenectady, N. Y.
Janette Mfg. Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio
Link-Belt Co., Chicago
Palmer-Bee Co., Hamtramck, Michigan
Winfield H. Smith, Inc., Springville, N
Stephens-Adamson Mfg. Co., Aurora,
Westinghouse Elec. & Mfg. Co., E. Pg
Worthington Pump & Machinery C
Harrison, N. J.

SPRAY EQUIPMENT [440]
Aeroil Burner Co., Inc., W. New York,
Binks Manufacturing Co., Chicago, Il
DeBothezat Vent. Equipment Div., A
Mach. & Metals, Inc., E. Moline, Il
DeVilbiss Co., Toledo
Driver-Harris Co., Harrison, N. J.
Eclipse Air Brush Co., Newark, N. J.
Macleod Co., Cincinnati, Ohio
Metallizing Engineering Co., Long Isl
City, N. Y.
Metalwash Machinery Co., Newark, N.
Paasche Airbrush Co., Chicago

SPRING COILING EQUIPMENT [44
Sleeper & Hartley, Inc., Worcester, M
Torrington Mfg. Co., Torrington, Con

SPRINGS [442]
Amer. Locomotive Co., Schenectady, N
American Steel & Wire, Cleveland, Oh
Associated Spring Corp.—Wallace Ba
Co. Div., Bristol, Conn.
John Chatillon & Sons, New York, N
Columbia Steel Co., San Francisco, C
Instrument Specialties Co., Little F
N. J.
Wickwire Spencer Steel Co., New York

SPRING STEELS [443]
Associated Spring Corp.—Wallace Ba
Co. Div., Bristol, Conn.
Bethlehem Steel Co., Bethlehem, Pa.
Cold Metal Products Co., Youngstown
Inland Steel Co., Chicago
Jessop Steel Co., Washington, Pa.
Republic Steel Corp., Cleveland
Thomas Steel Co., Warren, Ohio
Timken Roller Bearing Co., Canton,
Edgar T. Wards Sons Co., Pittsburgh

STAMPINGS OR DRAWINGS—M [444]
Aluminum Co., of America, Pittsburgh,
American Pulley Co., Philadelphia, Pa
Associated Spring Corp.—Wallace Ba
Co. Div., Bristol, Conn.
Brewer-Titchener Corp., Cortland, N.
Bridgeport Brass Co., Bridgeport, Con
By-Products Steel Corp., Coatesville, P
Central Iron & Steel Co., Harrisburg,
Copperweld Steel Co., Warren, Ohio
Follansbee Steel Corp., Pittsburgh, Pa
Globe Machine & Stamping Co., Cleve
Glyco Products Co., Inc., Brooklyn, N
Hydro Mfg. Co., Detroit
Ingersoll Steel & Disc Div., Borg-Wa
Corp., New Castle, Ind.
Logan Co., Louisville, Ky.
Lukens Steel Co., Coatesville, Pa.
Poulsen & Nardon, Inc., Los Angeles
Pressed Steel Co., Wilkes-Barre, Pa.
Republic Steel Corp., Cleveland, Ohio
Revere Copper & Brass, Inc., New York
Reynolds Metals Co., Louisville, Ky.
Scovill Mfg. Co., Waterbury, Conn.
Transue & Williams Steel Forging Co
Alliance, Ohio
Western Cartridge Co., East Alton, Il
Worcester Pressed Steel Co., Worces
Mass.
Wrought Washer Mfg. Co., Milwaukee

STEEL—Acid Resisting [445]
Allegheny Ludlum Steel Corp., Brack
ridge, Pa.
Amer. Mang. Steel Div., American B
Shoe Co., Chicago Hts.
American Steel & Wire, Cleveland, Oh
G. O. Carlson, Inc., Thorndale, Pa.
Carnegie-Illinois Steel Corp., Pgh., Pa
Carpenter Steel Co., Reading, Pa.
Chicago Steel Foundry Co., Chicago, I
Columbia Steel Co., San Francisco, Ca
Henry Disston & Sons, Inc., Philadel
Wilbur B. Driver Co., Newark, N. J.
Driver-Harris Co., Harrison, N. J.
Duraloy Co., Scottdale, Pa.

RAPID STEEL INSPECTION

With Magnetic Analysis Equipments steel bars and tubes are tested at production speed for faults and mix-ups, the human factor in inspection minimized and labor costs greatly reduced with resultant savings in time and material.

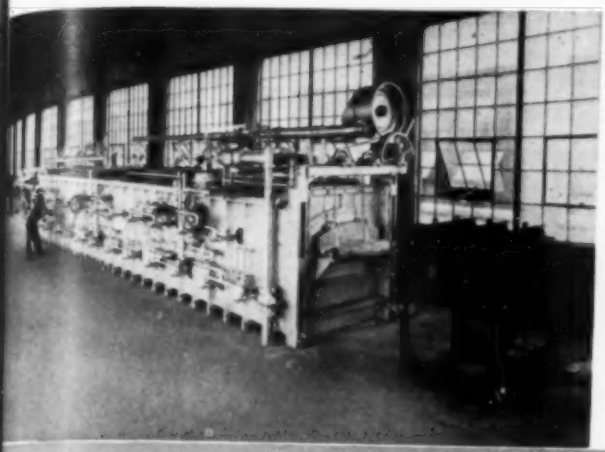
This economical form of continuous non-destructive testing meets all modern requirements since in a single passage every piece of material is tested and given a double inspection by the dual method incorporated in these equipments. All necessity for making separate tests is thus eliminated and for further economy, sections with flaws can be easily located and cut out, permitting the salvage of good material.

Material for testing needs no preparation as this inspection method is not affected by grease, dirt, scale or rust, and because it is not contacted in any way, chances of injuring it are eliminated.

By employing Demagnetizing Equipments with Magnetic Analysis Equipments, material is demagnetized and inspected in the same passage and since the operation of both of these equipments is semi-automatic, only a single operator with the skill of an average mill inspector is required.

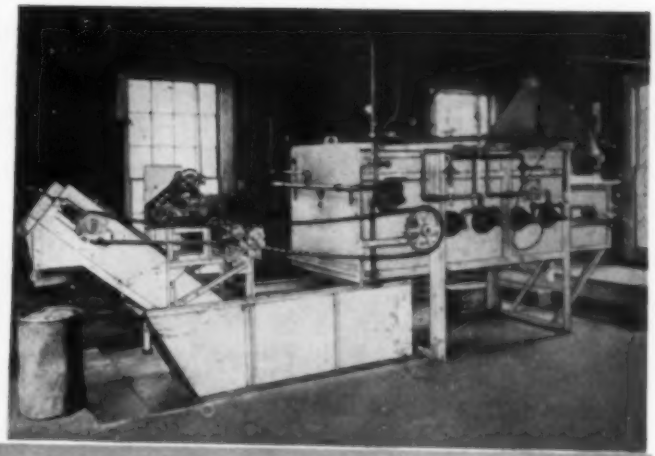
Upon request further information about Magnetic Analysis and Demagnetizing Equipments will be forwarded and if desired arrangements made for a field engineer to call at your plant.

MAGNETIC ANALYSIS CORPORATION, Long Island City, N.Y.



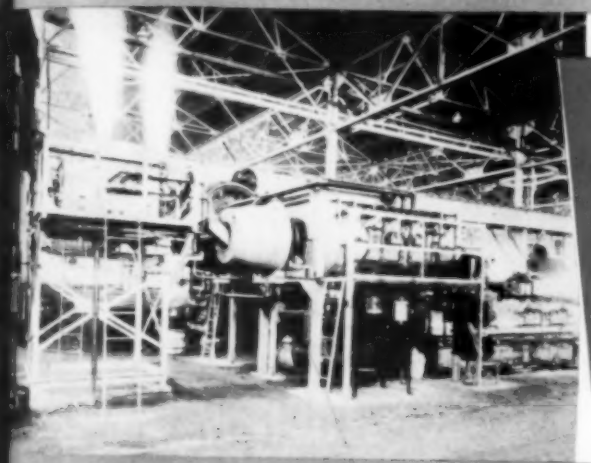
ANNEALING STAINLESS STEEL STRIP

Recent installation of a continuous catenary type furnace handling 3300 lbs. of strip per hour; 36 ft. long x 4'6" wide; butane gas fired.



HARDENING STEEL SPRINGS

One of several types of fully automatic hardening furnaces, discharging work into a conveyor quench tank; gas fired.



WASHING · ANNEALING · PICKLING BRASS CUPS

A completely automatic set-up of a washing machine, gas fired revolving retort annealing furnace and rotary drum pickling machine synchronized for continuous feed and discharge of 3000 lbs. per hour.

Let Heating Quality Dictate Your Furnace Selection

What should you expect of the furnace you need? Faster production? Yes. Economical heating? Yes, that too. But most important of all must be the certainty that your product is of the quality you expected from the heat treating operation. Translate that into furnace specifications and you get

1. Proper heat input, accurately controlled as to temperature, furnace atmosphere and time.
2. Complete thorough exposure of every part of every piece of work to uniform heating and cooling.
3. Rate of furnace production that coordinates efficiency with other processing operations.
4. Handling methods that tie into your other mill processes.

Fifty years of developing thousands of furnaces from their crude beginnings to today's modern precision heating units are your sound assurance that a Rockwell Furnace, whether a small batch furnace or complete conveyor type precleaning, heat treating and quenching equipment, is engineered for the job your process requires.

Get the whole Rockwell Furnace story. Write for Catalog.

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OIL · GAS · ELECTRIC

W. S. ROCKWELL COMPANY

BATCH TYPE & CONVEYOR FURNACES FOR EVERY HEATING APPLICATION

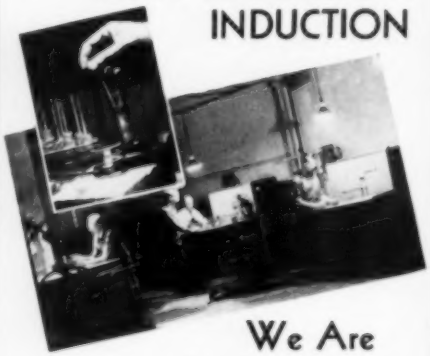
46 CHURCH STREET NEW YORK 7, N. Y.

• COMMERCIAL HEAT-TREATERS •

Modern LOCALIZED HEAT TREATMENT & BRAZING

SPECIALIZING IN

HIGH FREQUENCY INDUCTION



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FOR HEAT TREATING

Accuracy . . . Heating time and temperature automatically controlled.

Localizing . . . Only those areas requiring hardening are treated; Cam Surfaces, Gear Teeth, Ends or Center Portions of rods, etc., or entire pieces.

• • •

FOR BRAZING

Localizing . . . Heat applied only where metals are joined; heat application limited to very narrow area.

Appearance . . . Pieces are left practically free of scale, discoloration and warpage.

Adaptability . . . Permits joining of intricate and delicate precision parts.

NOW SERVING LEADING WAR PLANTS

Check this modern method for your heat treatment needs.

Induction Heat Treating

Eastern

HEAT TREATING & BRAZING CORP

250 WEST 54TH STREET, NEW YORK, N.Y.

HARDENING ANNEALING SOLDERING BRAZING

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Duriron Co., Inc., Dayton, O.
Fahralloy Co., Harvey, Ill.
Firth-Sterling Steel Co., McKeesport, Pa.
Peter A. Frasse & Co., Inc., New York
General Alloys Co., Boston, Mass.
Industrial Steels, Inc., Cambridge, Mass.
Ingersoll Steel & Disc Div., Borg-Warner Corp., New Castle, Ind.
Joslyn Mfg. & Supply Co., Ft. Wayne, Ind.
Latrobe Electric Steel Co., Latrobe, Pa.
Lukens Steel Co., Coatesville, Pa.
Michigan Steel Casting Co., Detroit, Mich.
Midvale Co., Nicetown, Philadelphia, Pa.
National Forge & Ordnance Co, Irvine, Pa.
Ohio Steel Foundry Co., Springfield, Ohio
Republic Steel Corp., Cleveland, Ohio
Rustless Iron & Steel Corp., Balt., Md.
Jos. T. Ryerson & Son, Inc., Chicago
Sterling-Alloys, Inc., Woburn, Mass.
Superior Steel Corp., Carnegie, Pa.
Timken Roller Bearing Co., Canton, O.
Edgar T. Ward's Sons Co., Pittsburgh

STEEL—Alloy [446]
Achorn Steel Co., Boston, Mass.
Alan Wood Steel Co., Conshohocken, Pa.
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Amer. Mang. Steel Div., American Brake Shoe Co., Chicago Hts.
Amer. Steel & Wire, Cleveland, Ohio
Andrews Steel Co., Newport, Ky.
Atlantic Steel Co., New York
Atlas Foundry Co., Irvington, N. J.
Atlas Steels, Ltd., Welland, Canada
Babcock & Wilcox Tube Co., Beaver Falls, Pa.
Beals-McCarthy & Rogers, Inc., Buffalo
Benedict-Miller, Inc., Newark, N. J.
Bethlehem Steel Co., Bethlehem, Pa.
Bissett Steel Co., Cleveland
Bliss & Laughlin, Inc., Harvey, Ill.
Brown-Wales Co., Boston, Mass.
Carnegie-Illinois Steel Corp., Pgh., Pa.
Carpenter Steel Co., Reading, Pa.
Central Steel & Wire Co., Chicago
John Chatillon & Sons, New York, N. Y.
Chicago Steel Foundry Co., Chicago, Ill.
Columbia Steel Co., San Francisco, Calif.
Columbia Tool Steel Co., Chicago Hts.
Cooper Alloy Fdry. Co., Hillside, N. J.
Copperweld Steel Co., Warren, Ohio
Crucible Steel Co. of America, New York
Cuyahoga Steel & Wire Co., Cleveland
Darwin & Milner, Cleveland
Henry Disston & Sons, Inc., Phila., Pa.
Wilbur B. Driver Co., Newark, N. J.
Driver-Harris Co., Harrison, N. J.
Duraloy Co., Scottdale, Pa.
Empire Steel Castings, Inc., Reading, Pa.
Erie Forge Co., Erie, Pa.
Faitoute Iron & Steel Co., Newark, N. J.
Firth-Sterling Steel Co., McKeesport, Pa.
Follansbee Steel Corp., Pittsburgh, Pa.
Forging & Casting Corp., Ferndale, Mich.
Peter A. Frasse & Co., Inc., New York
Great Lakes Steel Corp., Detroit, Mich.
Heller Brothers Co., Newark, N. J.
Heppenstall Co., Pittsburgh, Pa.
W. J. Holliday & Co., Hammond, Ind.
Ingersoll Steel & Disc Div., Borg-Warner Corp., New Castle, Ind.
William Jessop & Sons, Inc., N. Y. City
Jessop Steel Co., Washington, Pa.
Joslyn Mfg. & Supply Co., Ft. Wayne, Ind.
Kloster Steel Corp., Chicago
La Salle Steel Co., Hammond, Ind.
Latrobe Electric Steel Co., Latrobe, Pa.
Lukens Steel Co., Coatesville, Pa.
Manganese Steel Forge Co., Philadelphia
Michigan Steel Casting Co., Detroit, Mich.
Midvale Co., Nicetown, Philadelphia, Pa.
A. Milne & Co., New York
Monarch Steel Co., Indianapolis, Ind.
National Forge & Ordnance Co., Irvine, Warren County, Pa.
Nitralloy Corp., New York
Ohio Steel Foundry Co., Springfield, O.
Peninsular Steel Co., Cleveland
Pennsylvania Iron & Steel Co., Los Angeles, Calif.
Horace T. Potts Co., Philadelphia, Pa.
Republic Steel Corp., Cleveland, Ohio
Rotary Electric Steel Co., Detroit, Mich.
Jos. T. Ryerson & Son, Inc., Chicago
Sharon Steel Corp., Sharon, Pa.
Simonds Saw & Steel Co., Fitchburg, Mass.
SKF Steels, Inc., New York City
Standard Steel Works Div., Baldwin Locomotive Works, Philadelphia, Pa.
Superior Steel Corp., Carnegie, Pa.
Swedish-American Steel Corp., Brooklyn, N. Y.
Swedish Crucible Steel Co., Detroit
Taylor-Wharton Iron & Steel Co., High Bridge, N. J.
Tenn. Coal, Iron & R. R. Co., Birm., Ala.
Timken Roller Bearing Co., Canton, O.
Tube Reducing Corp., Wallington, N. J.
U. S. Steel Supply Co., Chicago
Vanadium-Alloys Steel Co., Pgh., Pa.
Vulcan Crucible Steel Co., Aliquippa, Pa.
Edgar T. Ward's Sons Co., Pittsburgh
Washington Iron Wks., Seattle, Wash.
Wheelock, Lovejoy, Cambridge, Mass.
Youngstown Sheet & Tube Co., Youngstown, O.
Ziv Steel & Wire Co., Chicago, Ill.

STEEL—Alloy Tubing [447]
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Bethlehem Steel Co., Bethlehem, Pa.
Bissett Steel Co., Cleveland
Bundy Tubing Co., Detroit
Carpenter Steel Co., Reading, Pa.
Chicago Steel Foundry Co., Chicago,
Columbia Steel Co., San Francisco, Ca
Driver-Harris Co., Harrison, N. J.
Peter A. Frasse & Co., Inc., New York
Globe Steel Tubes Co., Milwaukee
Michigan Steel Casting Co., Detroit
National Forge & Ordnance Co., Irv
Warren County, Pa.
National Tube Co., Pittsburgh, Pa.
Ohio Seamless Tube Co., Shelby, Ohio
Ohio Steel Foundry Co., Springfield, O
Republic Steel Corp., Cleveland, Ohio
Revere Copper & Brass Co., New Yor
Jos. T. Ryerson & Son, Inc., Chicago
SKF Steels, Inc., New York City
Summerill Tubing Co., Bridgeport, Pa
Timken Roller Bearing Co., Canton, O.
Tube Reducing Corp., Newark, N. J.
Tube Reducing Corp., Wallington, N.
Tubular Alloy Steel Corp., Gary, Ind.

STEEL—Carbon [448]
Achorn Steel Co., Boston, Mass.
Alan Wood Steel Co., Conshohocken, Pa.
Amer. Mang. Steel Div., Amer. Brake Sh
Co., Chicago Hts., Ill.
Amer. Steel & Wire, Cleveland, Ohio
Andrews Steel Co., Newport, Ky.
Atlantic Steel Co., New York
Atlas Steels, Ltd., Welland, Canada
Beals-McCarthy & Rogers, Inc., Buffalo
Benedict-Miller, Inc., Newark, N. J.
Bethlehem Steel Co., Bethlehem, Pa.
Bliss & Laughlin, Inc., Harvey, Ill.
Brown-Wales Co., Boston, Mass.
Carnegie-Illinois Steel Corp., Pgh., Pa.
Carpenter Steel Co., Reading, Pa.
Central Iron & Steel Co., Harrisburg, Pa.
Central Steel & Wire Co., Chicago
Chicago Steel Foundry Co., Chicago
Columbia Steel Co., San Francisco, Ca
Columbia Tool Steel Co., Chicago Hts.
Copperweld Steel Co., Glassport, Pa.
Cuyahoga Steel & Wire Co., Clevelan
Darwin & Milner, Cleveland
Henry Disston & Sons, Inc., Phila., Pa.
Erie Forge Co., Erie, Pa.
Faitoute Iron & Steel Co., Newark, N.
Firth-Sterling Steel Co., McKeesport, Pa
Follansbee Steel Corp., Pittsburgh, Pa.
Peter A. Frasse & Co., Inc., New York
Granite City Steel Co., Granite City,
Great Lakes Steel Corp., Ecorse, Det
Heller Brothers Co., Newark, N. J.
Heppenstall Co., Pittsburgh
W. J. Holliday & Co., Hammond, Ind.
**Ingersoll Steel & Disc Div., Borg-War
Corp., New Castle, Ind.**
Inland Steel Co., Chicago
Joslyn Mfg. & Supply Co., Ft. Wayne, I
Kloster Steel Corp., Chicago
Laclede Steel Co., St. Louis, Mo.
La Salle Steel Co., Hammond, Ind.
Latrobe Electric Steel Co., Latrobe, Pa
Lukens Steel Co., Coatesville, Pa.
Michigan Steel Casting Co., Detroit
A. Milne & Co., New York
Monarch Steel Co., Indianapolis, In
National Forge & Ordnance Co., Ir
Warren County, Pa.
National Steel Corp., Pittsburgh, Pa.
Ohio Steel Foundry Co., Springfield,
Peninsular Steel Co., Cleveland
Horace T. Potts Co., Philadelphia, P
Republic Steel Corp., Cleveland, Ohio
Jos. T. Ryerson & Son, Inc., Chicago

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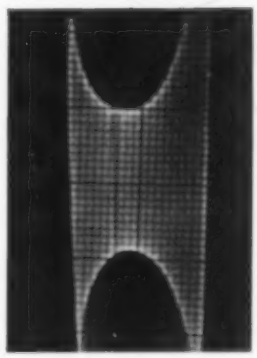
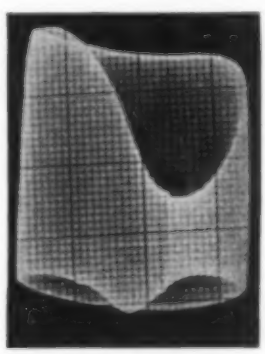


Typical DuMont cyclogram as read by the operator. This reading is for the depth of case-hardening. Each division of grating represents .01". Waist thickness equals 22 tenths, closely corresponding to microscopic measurement of same piece at .021" case depth.



Another DuMont cyclogram, this time indicating high internal stresses. The Cyclograph may be used to distinguish between two pieces of steel having the same hardness, one of which has low internal stresses and the other higher internal stresses and therefore more brittle.

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Superior Steel Corp., Carnegie, Pa.
Swedish-American Steel Corp., Brooklyn, N. Y.
Swedish Crucible Steel Co., Detroit
Tenn. Coal, Iron & R. R. Co., Birm., Ala.
Timken Roller Bearing Co., Canton, O.
U. S. Steel Supply Co., Chicago
Vulcan Crucible Steel Co., Aliquippa, Pa.
Edgar T. Ward's Sons Co., Pittsburgh
Weirton Steel Company, Weirton, W. Va.
Youngstown Sheet & Tube Co., Youngstown, Ohio
Ziv Steel & Wire Co., Chicago, Ill.

STEEL—Carbon Tubing [449]
Bethlehem Steel Co., Bethlehem, Pa.
Bundy Tubing Co., Detroit
Columbia Steel Co., San Francisco, Calif.
Peter A. Frasse & Co., Inc., New York
Laclede Steel Co., St. Louis, Mo.
Michigan Steel Tube Products Co., Detroit
National Forge & Ordnance Co., Irvine, Warren County, Pa.
National Tube Co., Pittsburgh, Pa.
Ohio Seamless Tube Co., Shelby, Ohio
Republic Steel Corp., Cleveland, Ohio
Jos. T. Ryerson & Son, Inc., Chicago
Summerill Tubing Co., Bridgeport, Pa.
Timken Roller Bearing Co., Canton, O.
Tube Reducing Corp., Newark, N. J.
Tube Reducing Corp., Wallington, N. J.
Tubular Alloy Steel Corp., Gary, Ind.
Edgar T. Ward's Sons Co., Philadelphia
Edgar T. Ward's Sons Co., Pittsburgh

STEEL—Clad [450]
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Follansbee Steel Corp., Pittsburgh, Pa.
Handy & Harman, New York
Ingersoll Steel & Disc, Chicago
Jessop Steel Co., Washington, Pa.
Lukens Steel Co., Coatesville, Pa.
Superior Steel Corp., Carnegie, Pa.
Tube Reducing Corp., Wallington, N. J.

STEEL—Cold Drawn [451]
Amer. Steel & Wire, Cleveland, Ohio
Beals-McCarthy & Rogers, Inc., Buffalo
Benedict-Miller, Inc., Newark, N. J.
Bethlehem Steel Co., Bethlehem, Pa.
Bissett Steel Co., Cleveland
Bliss & Laughlin, Inc., Harvey, Ill.
Brown-Wales Co., Boston, Mass.
Callite Tungsten Corp., Union City, N. J.
Carnegie-Illinois Steel Corp., Pgh., Pa.
Carpenter Steel Co., Reading, Pa.
Central Steel & Wire Co., Chicago
Columbia Steel & Shafting Co., Pittsburgh
Copperweld Steel Co., Warren, Ohio
Driver-Harris Co., Harrison, N. J.
Firth-Sterling Steel Co., McKeesport, Pa.
Fitzsimons Co., Youngstown, Ohio
Peter A. Frasse & Co., Inc., New York
Hill-Chase & Co., Philadelphia
W. J. Holliday & Co., Hammond, Ind.
Jessop Steel Co., Washington, Pa.
Joslyn Mfg. & Supply Co., Ft. Wayne, Ind.
Keystone Drawn Steel Co., Spring City, Pa.
La Salle Steel Co., Hammond, Ind.
Latrobe Electric Steel Co., Latrobe, Pa.
Monarch Steel Co., Indianapolis, Ind.
Peninsular Steel Co., Cleveland
Penn. Iron & Steel Co., Los Angeles, Cal.
Pittsburgh Tool Steel Wire Co., Monaca, Pa.
Horace T. Potts Co., Philadelphia, Pa.
A. R. Purdy Co., Inc., New York
A. B. & J. Rathbone, Palmer, Mass.
Republic Steel Corp., Cleveland, Ohio
Rotary Electric Steel Co., Detroit, Mich.
Jos. T. Ryerson & Son, Inc., Chicago
Timken Roller Bearing Co., Canton, O.
U. S. Steel Supply Co., Chicago
Vanadium-Alloys Steel Co., Latrobe, Pa.
Edgar T. Ward's Sons Co., Philadelphia
Edgar T. Ward's Sons Co., Pittsburgh
Wyckoff Drawn Steel Co., Pittsburgh, Pa.

STEEL—Cold Rolled Strip [452]
Achorn Steel Co., Boston, Mass.
Acme Steel Co., Chicago, Ill.
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Amer. Rolling Mill Co., Middletown, O.
Amer. Steel & Wire Co., Cleveland, Ohio
Bethlehem Steel Co., Bethlehem, Pa.
Carnegie-Illinois Steel Corp., Pittsburgh
Carpenter Steel Co., Reading, Pa.
Cold Metal Products Co., Youngstown, O.
Columbia Steel Co., San Francisco, Calif.
Firth-Sterling Steel Co., McKeesport, Pa.
Follansbee Steel Corp., Pittsburgh, Pa.
Peter A. Frasse & Co., Inc., New York
Great Lakes Steel Corp., Ecorse, Detroit
Hill-Chase & Co., Philadelphia
W. J. Holliday & Co., Hammond, Ind.
Inland Steel Co., Chicago
Keystone Drawn Steel Co., Spring City, Pa.
National Steel Corp., Pittsburgh, Pa.
Republic Steel Corp., Cleveland, Ohio
Jos. T. Ryerson & Son, Inc., Chicago
Sandvik Steel, Inc., New York
Sharon Steel Corp., Sharon, Pa.
Stanley Works, New Britain, Conn.
Charles G. Stevens Co., Chicago, Ill.
Superior Steel Corp., Carnegie, Pa.
Tenn. Coal, Iron & R. R. Co., Birm., Ala.
Thomas Steel Co., Warren, Ohio
U. S. Steel Supply Co., Chicago
Edgar T. Ward's Son Co., Philadelphia
Edgar T. Ward's Sons Co., Pittsburgh
Weirton Steel Co., Weirton, W. Va.
Wickwire Spencer Steel Co., New York
Worcester Pressed Steel Co., Worcester

STEEL—Drill, Hollow [453]
Achorn Steel Co., Boston, Mass.
Atlas Steels, Ltd., Welland, Canada
Bethlehem Steel Co., Bethlehem, Pa.
Crucible Steel Co. of America, New York
Kloster Steel Corp., Chicago
Midvale Co., Nicetown, Philadelphia, Pa.
A. Milne & Co., New York
Peninsular Steel Co., Cleveland
Sandvik Steel, Inc., New York
Swedish-American Steel Corp., Brooklyn, N. Y.
Edgar T. Ward's Sons Co., Philadelphia
Ziv Steel & Wire Co., Chicago, Ill.

STEEL—Electrical or Silicon [454]
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
American Rolling Mill Co., Middletown, O.
Bethlehem Steel Co., Bethlehem, Pa.
Carnegie-Illinois Steel Corp., Pgh., Pa.
Carpenter Steel Co., Reading, Pa.
Columbia Steel Co., San Francisco, Calif.
Follansbee Steel Corp., Pittsburgh, Pa.
Granite City Steel Co., Granite City, Ill.
Ingersoll Steel & Disc, New Castle, Ind.
Inland Steel Co., Chicago
Latrobe Electric Steel Co., Latrobe, Pa.
National Forge & Ordnance Co., Irvine, Warren County, Pa.
Plastic Metals, Inc., Johnstown, Pa.
Republic Steel Corp., Cleveland, Ohio
Jos. T. Ryerson & Son, Inc., Chicago
U. S. Steel Supply Co., Chicago
Edgar T. Ward's Son Co., Philadelphia
Edgar T. Ward's Son Co., Pittsburgh

STEEL—Hot Rolled Strip [455]
Acme Steel Co., Chicago, Ill.
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Amer. Rolling Mill Co., Middletown, O.
Amer. Steel & Wire Co., Cleveland, Ohio
Bethlehem Steel Co., Bethlehem, Pa.
Carnegie-Illinois Steel Corp., Pgh., Pa.
Carpenter Steel Co., Reading, Pa.
Columbia Steel Co., San Francisco, Calif.
Driver-Harris Co., Harrison, N. J.
Firth-Sterling Steel Co., McKeesport, Pa.
Peter A. Frasse & Co., Inc., New York
Granite City Steel Co., Granite City, Ill.
Great Lakes Steel Corp., Ecorse, Detroit
W. J. Holliday & Co., Hammond, Ind.
Inland Steel Co., Chicago
Laclede Steel Co., St. Louis, Mo.
Republic Steel Corp., Cleveland, Ohio
Jos. T. Ryerson & Son, Inc., Chicago
Sharon Steel Corp., Sharon, Pa.
Stanley Works, New Britain, Conn.
Superior Steel Corp., Carnegie, Pa.
Tenn. Coal, Iron & R. R. Co., Birm., Ala.
U. S. Steel Supply Co., Chicago
Weirton Steel Co., Weirton, W. Va.

STEEL—Nitriding [456]
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Bellis Heat Treating Co., Branford, Conn.
Bethlehem Steel Co., Bethlehem, Pa.
Carnegie-Illinois Steel Corp., Pgh., Pa.
Copperweld Steel Co., Warren, Ohio
Driver-Harris Co., Harrison, N. J.
E. I. du Pont de Nemours & Co., Inc., Wilmington, Dela.
Firth-Sterling Steel Co., McKeesport, Pa.
Peter A. Frasse & Co., Inc., New York
A. Milne & Co., New York
Nitralloy Corp., New York, N. Y.
Republic Steel Corp., Cleveland, Ohio
Rotary Electric Steel Co., Detroit
Superior Steel Corp., Carnegie, Pa.
Timken Roller Bearing Co., Canton, O.

STEEL—Plated [457]
American Nickeloid Co., Peru, Ill.
W. J. Holliday & Co., Hammond, Ind.
Thomas Steel Co., Warren, Ohio

STEEL—Stainless [458]
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Alloy Casting Co., Champaign, Ill.
Amer. Mang. Steel Div., American Brake Shoe Co., Chicago Hts.
American Rolling Mill Co., Middletown, O.
American Steel & Wire, Cleveland, Ohio
Atlas Foundry Co., Irvington, N. J.
Atlas Steels, Ltd., Welland, Canada
Bethlehem Steel Co., Bethlehem, Pa.
G. O. Carlson, Inc., Thorndale, Pa.
Carnegie-Illinois Steel Corp., Pgh., Pa.
Carpenter Steel Co., Reading, Pa.
Chicago Steel Foundry Co., Chicago, Ill.
Cold Metal Products Co., Youngstown, O.
Columbia Steel Co., San Francisco, Calif.
Columbia Tool Steel Co., Chicago Hts.
Cooper Alloy Foundry Co., Hillside, N. J.
Copperweld Steel Co., Warren, Ohio
Crucible Steel Co. of America, New York
Wilbur B. Driver Co., Newark, N. J.
Driver-Harris Co., Harrison, N. J.
Duraloy Co., Scottdale, Pa.
Duriron Co., Dayton, Ohio
Empire Steel Castings, Inc., Reading, Pa.
Fahralloy Co., Harvey, Ill.
Firth-Sterling Steel Co., McKeesport, Pa.
Peter A. Frasse & Co., Inc., New York
General Alloys Co., Boston, Mass.
W. J. Holliday & Co., Hammond, Ind.
Industrial Steels, Inc., Cambridge, Mass.
Ingersoll Steel & Disc Div., Borg-Warner Corp., New Castle, Ind.
William Jessop & Sons, Inc., N. Y. City
Jessop Steel Co., Washington, Pa.
Joslyn Mfg. & Supply Co., Ft. Wayne, Ind.
Latrobe Electric Steel Co., Latrobe, Pa.
Lukens Steel Co., Coatesville, Pa.
Michigan Steel Casting Co., Detroit
Midvale Co., Nicetown, Philadelphia, Pa.
National Forge & Ordnance Co., Irvine, Warren County, Pa.
Ohio Steel Foundry Co., Springfield, Ohio
Pittsburgh Steel Co., Pittsburgh, Pa.
Horace T. Potts Co., Philadelphia
Republic Steel Corp., Cleveland
Rustless Iron & Steel Corp., Balt., Md.
Jos. T. Ryerson & Son, Inc., Chicago
Sharon Steel Corp., Sharon, Pa.
Charles G. Stevens Co., Chicago, Ill.
Superior Steel Corp., Carnegie, Pa.
Tenn. Coal, Iron & R. R. Co., Birm., Ala.
Timken Roller Bearing Co., Canton, O.
U. S. Steel Supply Co., Chicago
Univ.-Cyclops Steel Corp., Bridgeville, Pa.
Edgar T. Ward's Son Co., Pittsburgh

STEEL—Stainless Clad [459]
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
H. Boker & Co., Inc., New York
Granite City Steel Co., Granite City, Ill.
Ingersoll Steel & Disc Div., Borg-Warner Corp., New Castle, Ind.
Jessop Steel Co., Washington, Pa.
Jos. T. Ryerson & Son, Inc., Chicago
Superior Steel Corp., Carnegie, Pa.
Univ.-Cyclops Steel Corp., Bridgeville, Pa.

STEEL—Stainless Cloth & Belts [460]
Audubon Wire Cloth Corp., Philadelphia
Cyclone Fence Div., Amer. Steel & Wire Co., Waukegan, Ill.
Rolock, Inc., Fairfield, Conn.
Sandvik Steel, Inc., New York City

STEEL—Strip [461]
Acme Steel Co., Chicago
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
American Nickeloid Co., Peru, Ill.
Amer. Rolling Mill Co., Middletown, O.
American Steel & Wire Co., Cleveland
Bethlehem Steel Co., Bethlehem, Pa.
Carnegie-Illinois Steel Corp., Pittsburgh
Carpenter Steel Co., Reading, Pa.

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Inland Steel Co., Chicago
Jessop Steel Co., Washington, Pa.
Laclede Steel Co., St. Louis, Mo.
Republic Steel Corp., Cleveland
Sharon Steel Corp., Sharon, Pa.
Superior Steel Corp., Carnegie, Pa.
Thomas Steel Co., Warren, Ohio
U. S. Steel Supply Co., Chicago

STEEL—Tool [462]
Achorn Steel Co., Boston, Mass.
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Atlantic Steel Co., New York
Atlas Steels, Ltd., Welland, Canada
Beals-McCarthy & Rogers, Inc., Buffalo
Benedict-Miller, Inc., Newark, N. J.
Bethlehem Steel Co., Bethlehem, Pa.
Bissett Steel Co., Cleveland
H. Boker & Co., Inc., New York
Braeburn Alloy Steel Corp., Braeburn, Pa.
Carpenter Steel Co., Reading, Pa.
Cleveland Twist Drill Co., Cleveland, Ohio
Columbia Tool Steel Co., Chicago Hts.
Copperweld Steel Co., Warren, Ohio
Crucible Steel Co. of America, New York
Henry Disston & Sons, Inc., Phila., Pa.
Darwin & Milner, Cleveland
Faitoute Iron & Steel Co., Newark, N. J.
Firth-Sterling Steel Co., McKeesport, Pa.
Follansbee Steel Corp., Pittsburgh, Pa.
Peter A. Frasse & Co., Inc., New York
Forging & Casting Corp., Ferndale, Mich.
Heller Brothers Co., Newark, N. J.
Heppenstall Co., Pittsburgh
Hill-Chase & Co., Philadelphia
W. J. Holliday & Co., Hammond, Ind.
Ingersoll Steel & Disc Div., Borg-Warner Corp., New Castle, Ind.
William Jessop & Sons, Inc., N. Y. City
Jessop Steel Co., Washington, Pa.
Joslyn Mfg. & Supply Co., Ft. Wayne, Ind.
Kloster Steel Corp., Chicago
Latrobe Electric Steel Co., Latrobe, Pa.
Midvale Co., Nicetown, Philadelphia, Pa.
A. Milne & Co., New York
Peninsular Steel Co., Cleveland
Horace T. Potts Co., Philadelphia
Thomas Prosser & Son, New York
A. R. Purdy Co., Inc., New York
Republic Steel Corp., Cleveland, Ohio
Jos. T. Ryerson & Son, Inc., Chicago
Sandvik Steel, Inc., New York
Simonds Saw & Steel, Fitchburg, Mass.
Swedish-Amer. Steel Corp., Brooklyn, N. Y.
Tenn. Coal, Iron & R.R. Co., Birm., Ala.
Timken Roller Bearing Co., Canton, O.
Uddeholm Co. of America, Inc., New York
U. S. Steel Supply Co., Chicago
Univ.-Cyclops Steel Corp., Bridgeville, Pa.
Vanadium Alloys Steel Co., Pittsburgh, Pa.
Vulcan Crucible Steel Co., Aliquippa, Pa.
Edgar T. Ward's Son Co., Pittsburgh
Wheelock, Lovejoy, Cambridge, Mass.
Ziv Steel & Wire Co., Chicago, Ill.

STEEL TUBING—Seamless and Welded [463]
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Babcock & Wilcox Tube Co., Beaver Falls, Pa.
Bethlehem Steel Co., Bethlehem, Pa.
Bissett Steel Co., Cleveland
Carpenter Steel Co., Reading, Pa.
Columbia Steel Co., San Francisco, Calif.
Peter A. Frasse & Co., Inc., New York
Globe Steel Tubes Co., Milwaukee, Wis.
Claud S. Gordon Co., Chicago, Ill.
Hill-Chase & Co., Philadelphia
Michigan Steel Tube Products Co., Detroit
National Forge & Ordnance Co., Irvine, Warren County, Pa.
National Tube Co., Pittsburgh, Pa.
Ohio Seamless Tube Co., Shelby, Ohio
Pittsburgh Steel Co., Pittsburgh, Pa.
A. R. Purdy Co., Inc., New York
Republic Steel Corp., Cleveland, Ohio
Revere Copper & Brass Co., New York
Jos. T. Ryerson & Son, Inc., Chicago
SKF Steels, Inc., New York
Summerill Tubing Co., Bridgeport, Pa.
Timken Roller Bearing Co., Canton, O.
Tube Reducing Corp., Newark, N. J.
Tube Reducing Corp., Wallington, N. J.
Tubular Alloy Steel Corp., Gary, Ind.
Van Huffel Tube Corp., Warren, O.
Edgar T. Ward's Sons Co., Pittsburgh

STRIP—Hot & Cold Rolled [464]
Acme Steel Co., Chicago, Ill.
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Aluminum Co. of America, Pittsburgh, Pa.
American Brass Co., Waterbury, Conn.
American Rolling Mill Co., Middletown, O.
American Steel & Wire, Cleveland, Ohio
Bethlehem Steel Co., Bethlehem, Pa.
Carnegie-Illinois Steel Corp., Pgh., Pa.
Carpenter Steel Co., Reading, Pa.
Cold Metal Products Co., Youngstown, O.
Columbia Steel Co., San Francisco, Calif.
Wilbur B. Driver Co., Newark, N. J.
Driver-Harris Co., Harrison, N. J.
Ekstrand & Tholand, Inc., New York
Follansbee Steel Corp., Pittsburgh, Pa.
Peter A. Frasse & Co., Inc., New York
Great Lakes Steel Corp., Ecorse, Detroit
W. J. Holliday & Co., Hammond, Ind.
Inland Steel Co., Chicago
Laclede Steel Co., St. Louis, Mo.
National Steel Corp., Pittsburgh, Pa.
Republic Steel Corp., Cleveland, Ohio
Revere Copper & Brass Co., New York
Jos. T. Ryerson & Son, Inc., Chicago
Sharon Steel Corp., Sharon, Pa.
Superior Steel Corp., Carnegie, Pa.
Tenn. Coal, Iron & R. R. Co., Birm., Ala.
U. S. Steel Supply Co., Chicago
Edgar T. Ward's Sons Co., Pittsburgh
Weirton Steel Co., Weirton, W. Va.
Whitehead Metal Products Co., New York

SUPERFINISHING STONES [465]
Carborundum Co., Niagara Falls, N. Y.
Norton Co., Worcester, Mass.

TANKS—Pickling [466]
Amer. Hard Rubber Co., New York
Atlas Mineral Prod. Co., Mertztown, Pa.
Continental-Diamond Fibre Co., Newark, Del.
Flinn & Dreffein Co., Chicago, Ill.
Haveg Corp., Newark, Delaware
Heil Engineering Co., Cleveland
Heilman Boiler Works, Allentown, Pa.
L. O. Koven & Bro., Inc., Jersey City, N. J.
MacDermid, Inc., Waterbury, Conn.
National Carbon Co., Inc., New York
Parsons Engr. Corp., Cleveland, Ohio
Pennsylvania Salt Mfg. Co., Phila., Pa.
Pittsburgh Plate Glass Co., Pittsburgh, Pa.
N. Ransohoff, Inc., Cincinnati, Ohio
Rolock, Inc., Fairfield, Conn.
Stanwood Corp., Chicago
U. S. Stoneware Co., Akron, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.
Wean Engineering Co., Inc., Warren, Ohio

TANKS—Plating [467]
American Hard Rubber Co., New York
Heil Engineering Co., Cleveland
Kirk and Blum Mfg. Co., Cincinnati, Ohio
L. O. Koven & Bro., Inc., Jersey City, N. J.
MacDermid, Inc., Waterbury, Conn.
Pittsburgh Plate Glass Co., Pittsburgh, Pa.
Protective Coatings, Inc., Detroit
N. Ransohoff, Inc., Cincinnati, Ohio
U. S. Stoneware Co., Akron, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.

TANKS—Quench [468]
Am. Gas Furnace Co., Elizabeth, N. J.
Bell and Gossett Co., Morton Grove, Ill.
Bellis Heat Treating Co., Branford, Conn.
Despatch Oven Co., Minneapolis, Minn.
L. O. Koven & Bro., Inc., Jersey City, N. J.
Lindberg Engineering Co., Chicago
MacDermid, Inc., Waterbury, Conn.
Metalwash Machinery Co., Irvington, N. J.
Parsons Engineering Corp., Cleveland
Pittsburgh Plate Glass Co., Pittsburgh, Pa.
N. Ransohoff, Inc., Cincinnati, Ohio
Rolock, Inc., Fairfield, Conn.
Stanwood Corp., Chicago
Tate-Jones & Co., Inc., Leetsdale, Pa.

TANTALUM [469]

TAPPING MACHINERY—Nut [470]
Acme Mach. Div., Hill Acme Co., Cleve., O.
Detroit Tap & Tool Co., Detroit
R. Y. Ferner Co., Boston, Mass.
National Machinery Co., Tiffin, Ohio

TEMPERATURE RECORDING PELLETS [471]
Eimer & Amend, New York
Tate-Jones & Co., Inc., Leetsdale, Pa.
Tempil Corp., New York

TENSILE TESTERS [471A]
W. C. Dillon & Co., Inc., Chicago

TESTING MACHINES [472]
All American Tool & Mfg. Co., Chicago
American Inst. Co., Silver Spring, Md.
Amthor Testing Inst. Co., Inc., Brooklyn
Anderson Bros. Mfg. Co, Rockford, Ill.
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia, Pa.
Barber-Colman Co., Rockford, Ill.
Brush Development Co., Cleveland, O.
John Chatillon & Sons, New York
Coats Machine Tool Co., Scarsdale, N. Y.
Detroit Testing Machine Co., Detroit
W. C. Dillon & Co., Inc., Chicago
Dravo Corp., Pittsburgh
Eimer & Amend, New York
R. Y. Ferner Co., Boston, Mass.
Andrew King, Narberth, Pa.
Kold-Hold Mfg. Co., Lansing, Mich.
Krouse Testing Mach. Co., Columbus
Link Engineering Co., Detroit
Magnetic Analysis Corp., Long Island
Tinius Olsen Testing Machine Co., Phila.
Physicists Research Co., Ann Arbor, Mich.
Pittsburgh Instrument & Machine Co., Pittsburgh, Pa.
Riehle Testing Machine Div.; American Machine & Metals, Inc., East Moline, Ill.
Scientific Supplies Co., Seattle, Wash.
Sonntag Scientific Corp., Greenwich, Conn.
Sperry Products, Inc., Hoboken, N. J.
Steel City Testing Lab., Detroit, Mich.
Sweden Freezer Mfg. Co., Seattle, Wash.
Taber Instr. Co., N. Tonawanda, N. Y.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Teleweld, Inc., Chicago
Testing Machines, Inc., New York
Toledo Scale Co., Toledo, Ohio
Wilson Mech. Instr. Co., Inc., New York

TESTING MACHINES—See Hardness Testing

THERMOCOUPLES [473]
Bellis Heat Treating Co., Branford, Conn.
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Callite Tungsten Corp., Union City, N. J.
Chicago Flexible Shaft Co., Chicago, Ill.
Harry W. Dietert Co., Detroit, Mich.
Wilbur B. Driver Co., Newark, N. J.
Charles Englehard, Inc., Newark, N. J.
R. A. Ekstrom, Jr. Co., Harvey, Ill.
Foxboro Co., Foxboro, Mass.
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago, Ill.
Hoskins Mfg. Co., Detroit, Mich.
Illinois Testing Lab., Inc., Chicago
J-B-T Instr., Inc., New Haven, Conn.
Leeds & Northrup Co., Philadelphia, Pa.
Arklay S. Richards Co., Inc., Newton Highlands, Mass.
E. H. Sargent & Co., Chicago
C. J. Tagliabue Mfg. Co., Brooklyn, N. Y.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Thwing-Albert Instr. Co., Philadelphia
Harold E. Trent Co., Philadelphia, Pa.
Vulcan Corp., Philadelphia
Wheelco Instruments Co., Chicago, Ill.

THERMOMETERS—Dial [474]
American Inst. Co., Silver Spring, Md.
Anderson & Sons, Westfield, Mass.
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Burrell Technical Supply Co., Pittsburgh
W. C. Dillon & Co., Inc., Chicago
Foxboro Co., Foxboro, Mass.
General Electric X-Ray Corp., Chicago
Claud S. Gordon Co., Chicago, Ill.
Gotham Instrument Co., New York
Illinois Testing Lab., Inc., Chicago
Leeds & Northrup Co., Philadelphia
Manning, Maxwell & Moore, Bridgeport, Conn.
Partlow Corp., New Hartford, N. Y.
Sarco Co., Inc., New York
E. H. Sargent & Co., Chicago, Ill.
C. J. Tagliabue Mfg. Co., Brooklyn, N. Y.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia
Wheelco Instruments Co., Chicago, Ill.

THERMOMETERS—Indicating [475]
Amer. Gas Furnace Co., Elizabeth, N. J.
American Inst. Co., Silver Spring, Md.
Anderson & Sons, Westfield, Mass.
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Burrell Technical Supply Co., Pittsburgh
W. C. Dillon & Co., Inc., Chicago
R. A. Ekstrom, Jr. Co., Harvey, Ill.

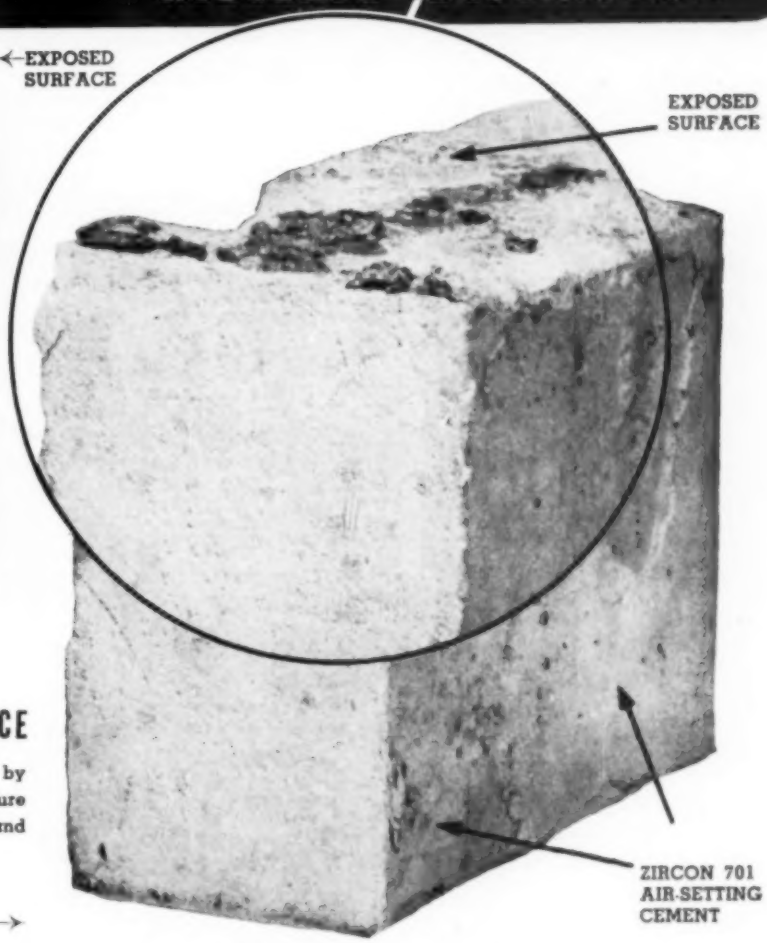
FOR THE ALUMINUM INDUSTRY

Taylor ZIRCON HEARTHS

produce cleaner metal

increase production

←EXPOSED SURFACE



DINARY FIRE BRICK AFTER SERVICE

gth of metamorphosed area is clearly shown by color change. Observe how the original structure been altered by penetration of aluminum and reaction with iron oxide and silica brick.

YLOR ZIRCON AFTER SERVICE→

tion thru TAYLOR ZIRCON BRICK removed from rth of aluminum re-melt furnace. 14,750,000 lbs. ted on this hearth. No penetration.

We think that these illustrations prove conclusively that, if the Refractory Industry ever developed a product which is unequalled, even uniquely fitted for one particular job, TAYLOR ZIRCON is certainly that product, when used for hearth construction in reverberatory type furnace for melting Aluminum.

Properties of TAYLOR ZIRCON REFRACTORIES and other pertinent data are given in Bulletin No. 200. Write for your copy today.

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Rockford Industrial Supply Co.

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Foxboro Co., Foxboro, Mass.
Claud S. Gordon Co., Chicago, Ill.
Gotham Instrument Co., New York
Illinois Testing Lab., Inc., Chicago
J-B-T Instr., Inc., New Haven, Conn.
Leeds & Northrup Co., Philadelphia, Pa.
Manning, Maxwell & Moore, Bridgeport, Conn.
Partlow Corp., New Hartford, N. Y.
E. H. Sargent & Co., Chicago, Ill.
C. J. Tagliabue Mfg. Co., Brooklyn, N. Y.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Taylor Instrument Co's., Rochester, N. Y.
Vulcan Corp., Philadelphia
Wheelco Instruments Co., Chicago, Ill.

THERMOMETERS—Metal [475A]
W. C. Dillon & Co., Inc., Chicago

THERMOMETERS—Recording [476]
Amer. Gas Furnace Co., Elizabeth, N. J.
Anderson & Sons, Westfield, Mass.
Bailey Meter Co., Cleveland, Ohio
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
R. A. Ekstrom, Jr. Co., Harvey, Ill.
Foxboro Co., Foxboro, Mass.
Claud S. Gordon Co., Chicago, Ill.
Gotham Instrument Co., New York
Leeds & Northrup Co., Philadelphia, Pa.
Manning, Maxwell & Moore, Bridgeport, Conn.
Partlow Corp., New Hartford, N. Y.
C. J. Tagliabue Mfg. Co., Brooklyn, N. Y.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Taylor Inst. Companies, Rochester, N. Y.
Vulcan Corp., Philadelphia
Wheelco Instruments Co., Chicago, Ill.

THERMOMETERS-BIMETALS [477]
C. S. Brainin Div., New York
Brown Instrument Co., Philadelphia, Pa.
Callite Tungsten Corp., Union City, N. J.
W. M. Chace Co., Detroit, Mich.
Dole Valve Co., Chicago
Driver-Harris Co., Harrison, N. J.
Westinghouse Electric & Mfg. Co., E. Pgh.
H. A. Wilson Co., Newark, N. J.

THREADING MACHINERY [478]
Acme Mach. Div., Hill Acme Co., Cleve., O.
Howe & Son, Inc., Hinsdale, N. H.
National Machinery Co., Tiffin, Ohio
Sheffield Corp., Dayton, Ohio

TIME CONTROLS [479]
American Inst. Co., Silver Spring, Md.
Automatic Temp. Control, Inc., Phila.
Bristol Co., Waterbury, Conn.
W. R. Cramer & Co., Centerbrook, Conn.
Foxboro Co., Foxboro, Mass.
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago, Ill.
Nat'l Time & Signal Corp., Detroit
Tate-Jones & Co., Inc., Leetsdale, Pa.
Taylor Inst. Companies, Rochester, N. Y.
Vulcan Corp., Philadelphia
Weltronic Corp., Detroit
Westinghouse Electric & Mfg. Co., E. Pgh.
Wheelco Instruments Co., Chicago, Ill.

TIN PLATE [480]
Bethlehem Steel Co., Bethlehem, Pa.
Carnegie-Illinois Steel Corp., Pgh., Pa.
Columbia Steel Co., San Francisco, Calif.
Granite City Steel Co., Granite City, Ill.
Inland Steel Co., Chicago
National Steel Corp., Pittsburgh, Pa.
Republic Steel Corp., Cleveland, Ohio
Tenn. Coal, Iron & R. R. Co., Birm., Ala.
Weirton Steel Co., Weirton, W. Va.
Youngstown Sheet & Tube Co., Youngstown, Ohio

TIPS—Spot Welding [481]
Air Reduction, New York
Callite Tungsten Corp., Union City, N. J.
P. R. Mallory & Co., Indianapolis, Ind.
S-M-S Corp., Detroit
Taylor-Winfield Corp., Warren, Ohio
Universal Power Corp., Cleveland
Welding Machines Mfg. Co., Detroit

TITANIUM [482]
Electro Ref. & Alloys Corp., Buffalo
Foote Mineral Co., Philadelphia, Pa.
Metal & Thermit Corp., New York
National Lead Co., New York
Niagara Falls Smelt. & Ref. Corp., Buffalo
Powder Metals & Alloys, Inc., New York
Titanium Alloy Mfg. Co., Niagara Falls
Vanadium Corp. of America, New York

TOOL BLANKS—Cemented Carbide [
Firth-Sterling Steel Co., McKeesport,
Kennametal, Inc., Latrobe, Pa.
Tungsten Elec. Corp., Union City, N.
Vascoloy-Ramet Corp., North Chicag
Willey's Carbide Tool Co., Detroit

TOOL & CUTTER GRINDERS [484]
Continental Machines, Inc., Minnea
Howe & Son, Inc., Hinsdale, N. H.
Landis Tool Co., Waynesboro, Pa.
K. O. Lee & Son, Aberdeen, S. D.
Norton Co., Worcester, Mass.
Production Mach. Co., Greenfield, M
Thomas Prosser & Son, New York
U. S. Steel Supply Co., Chicago

TOOLMAKERS MICROSCOPES [485]
All American Tool & Mfg. Co., Chic
Bausch & Lomb Opt. Co., Rochester, N.
Eberbach & Son Co., Ann Arbor, Mich.
Gaertner Scientific Corp., Chicago
Claud S. Gordon Co., Chicago, Ill.
George Scherr Co., New York, N. Y.
Carl Zeiss, Inc., New York

TOOLS—Cemented Carbide [486]
Allegheny Ludlum Steel Corp., Brack
ridge, Pa.
Carboloy Co., Inc., Detroit, Mich.
Firth-Sterling Steel Co., McKeesport, P
Genesee Tool Co., Fenton, Mich.
Jessop Steel Co., Washington, Pa.
Kennametal, Inc., Latrobe, Pa.
Lincoln Park Tool & Gage Co., Lin
Park, Mich.
Tungsten Carbide Tool Co., Detroit
Tungsten Elec. Corp., Union City, N.
Vascoloy-Ramet Corp., North Chicago
Willey's Carbide Tool Co., Detroit

TOOLS—Filing & Honing [487]
Continental Machines, Inc., Minneap
Heller Brothers Co., Newark, N. J.
Simonds Saw & Steel Co., Fitchburg, M

TOOLS—Metal Cutting [488]
Amer. Twist Drill Co., Detroit
Bethlehem Steel Co., Bethlehem, Pa.
Braeburn Alloy St. Corp., Braeburn,
Robert H. Clark Co., Los Angeles, C
Colonial Broach Co., Detroit
Continental Machines, Inc., Minneap
Delaware Tool Steel Corp., Wilmin
Delaware
Delloy Metals, Philadelphia, Pa.
Detroit Tap & Tool Co., Detroit
Firth-Sterling Steel Co., McKeesport,
Genesee Tool Co., Fenton, Mich.
Heppenstall Co., Pittsburgh
Illinois Tool Works, Chicago
Kennametal, Inc., Latrobe, Pa.
Master Tool Co., Inc., Cleveland
Michigan Tool Co., Detroit
Perfection Tool & Metal Heat Tre
Co., Chicago, Ill.
Production Mach. Co., Greenfield, M
Simonds Saw & Steel Co., Fitchburg, M
Tuff-Hard Corp., Detroit
Tungsten Carbide Tool Co., Detroit
Tungsten Elec. Corp., Union City, N.
Vascoloy-Ramet Corp., North Chicag

TORCHES—Brazing, Cutting and Wel
[489]
Air Reduction, New York
Amer. Gas Furnace Co., Elizabeth, N.
Dockson Corp., Detroit
Ergolyte Mfg. Co., Philadelphia
Harris Calorific Co., Cleveland, Ohio
Linde Air Products Co., New York
National Cylinder Gas Co., Chicago
Smith Welding Equip. Corp., Minnea
Surface Combustion, Toledo, Ohio
Tolman Mfg. Co., South Boston, Ma
Universal Power Corp., Cleveland
Victor Equipment Co., San Francisco

TORCHES—Preheating [490]
Amer. Gas Furnace Co., Elizabeth, N
Eclipse Fuel Engrg. Co., Rockford, Ill.
Hauck Manufacturing Co., Brooklyn,
Charles A. Hones, Inc., Baldwin, N.
Linde Air Products Co., New York
Mahr Manufacturing Co., Minneapol
National Cylinder Gas Co., Chicago
Surface Combustion, Toledo, Ohio
Tolman Mfg. Co., South Boston, Ma
Torit Mfg. Co., St. Paul, Minn.
Universal Power Corp., Cleveland
Vulcan Corp., Philadelphia

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THE paths to the peacetime pursuits of Tomorrow are still blocked by ruthless hordes of an enemy who would deny them to us forever. Until they are removed, every Titan employee intends to dedicate every effort to maintaining the attack. Titan's expanded and improved production facilities are still being utilized night and day to fulfill our Country's demands. When these demands are fully met Titan will again turn to serving your peacetime requirements.

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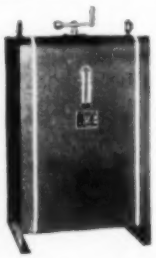
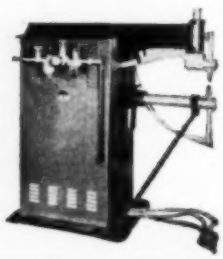


Spot, Butt, Flash, Seam or Gun Welder



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TRANSFORMERS—Furnace [491]
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Car & Foundry Co., New York
Bellis Heat Treating Co., Branford, Conn.
Detroit Electric Furnace Div., Kuhlman Electric Co., Bay City, Mich.
Eisler Engineering Co., Newark, N. J.
Electric Furnace Co., Salem, Ohio
General Electric Co., Schenectady, N. Y.
Claud S. Gordon Co., Chicago, Ill.
Hercules Elec. & Mfg. Co., Brooklyn, N. Y.
Pittsburgh Lectromelt Furn. Corp., Pittsburgh, Pa.
Welding Machines Mfg. Co., Detroit
Westinghouse Elec. & Mfg. Co., E. Pgh., Pa.

TRAYS—Metallurgical [492]
Alloy Casting Co., Champaign, Ill.
Amer. Mang. Steel Div., American Brake Shoe Co., Chicago Hts.
Chicago Steel Foundry Co., Chicago
Driver-Harris Co., Harrison, N. J.
Duraloy Co., Scottdale, Pa.
General Alloys Co., Boston, Mass.
Michigan Steel Casting Co., Detroit
National Carbon Co., Inc., Cleveland
National Carbon Co., Inc., New York
Ohio Steel Foundry Co., Springfield, O.
Stanwood Corp., Chicago
Sterling Alloys Co., Woburn, Mass.
Tate-Jones & Co., Inc., Leetsdale, Pa.

TRAYS—Wire [493]
Audubon Wire Cloth Corp., Philadelphia
Driver-Harris Co., Harrison, N. J.
C. O. Jelliff Mfg. Corp., Southport, Conn.
Ludlow-Saylor Wire Co., St. Louis
Newark Wire Cloth Co., Newark, N. J.
Rolock, Inc., Fairfield, Conn.
Stanwood Corp., Chicago
Tate-Jones & Co., Inc., Leetsdale, Pa.
Union Steel Products Co., Albion, Mich.
Whitehead Metal Products Co., New York
Willamette Hyster Co., Portland, Oregon

TUBES—Brass, Copper Bronze [494]
American Brass Co., Waterbury, Conn.
Bridgeport Brass Co., Bridgeport, Conn.
Chase Brass & Cop. Co., Waterbury, Conn.
Claud S. Gordon Co., Chicago, Ill.
Mueller Brass Co., Port Huron, Mich.
Parker Appliance Co., Cleveland, Ohio
Penn Brass & Copper Co., Erie, Pa.
Revere Copper & Brass Co., New York
Scovill Mfg. Co., Waterbury, Conn.
Tube Reducing Corp., Wallington, N. J.
Whitehead Metal Products Co., New York
Wolverine Tube Div., Detroit

TUBES—Centrifugally Cast, Stainless [495]
Benedict Miller, Inc., Newark, N. J.
Blaw-Knox Co., Pittsburgh, Pa.
Calorizing Co., Pittsburgh, Pa.
Cooper Alloy Foundry Co., Hillside, N. J.
Duraloy Co., Scottdale, Pa.
Haynes Stellite Co., Kokomo, Ind.
Michiana Prod. Corp., Michigan City, Ind.
Michigan Steel Casting Co., Detroit
Midvale Co., Nicetown, Philadelphia, Pa.
Ohio Steel Foundry Co., Springfield, O.
Shenango-Penn Mold Co., Dover, Ohio
Standard Alloy Co., Cleveland

TUBES—Gas Fired Radiant [496]
Alloy Casting Co., Champaign, Ill.
Alloy Mfg. Co., Inc., Pittsburgh, Pa.
Amer. Gas Assn., New York, N. Y.
Benedict Miller, Inc., Newark, N. J.
Carborundum Co., Niagara Falls, N. Y.
Chicago Steel Foundry Co., Chicago, Ill.
Continental Industrial Engineers, Chicago
Electric Furnace Co., Salem, O.
General Alloys Co., Boston, Mass.
C. M. Kemp Mfg. Co., Baltimore, Md.
Michiana Prod. Corp., Michigan City, Ind.
Michigan Steel Casting Co., Detroit
Midvale Co., Philadelphia
Ohio Steel Foundry Co., Springfield, O.
Pressed Steel Co., Wilkes-Barre, Pa.
Horace T. Potts Co., Philadelphia, Pa.
Standard Alloy Co., Cleveland
Sterling Alloy Co., Woburn, Mass.
Surface Combustion, Toledo, Ohio
Tate-Jones & Co., Inc., Leetsdale, Pa.
Timken Roller Bearing Co., Canton, O.
Vulcan Corp., Philadelphia

TUBES—Non-Ferrous [497]
Aluminum Co. of Amer., Pittsburgh, Pa.
American Brass Co., Waterbury, Conn.
Bunting Brass & Bronze Co., Toledo, O.
Haynes Stellite Co., Kokomo, Ind.
International Nickel Co., Inc., N. Y. City
P. R. Mallory & Co., Inc., Indianapolis
National Carbon Co., Inc., New York
Penn Brass & Copper Co., Erie, Pa.
Revere Copper & Brass, Inc., New York
Reynolds Metals Co., Louisville, Ky.
Scovill Mfg. Co., Waterbury, Conn.
Superior Tube Co., Norristown, Pa.
Tube Reducing Corp., Newark, N. J.
Tube Reducing Corp., Wallington, N. J.
Whitehead Metal Products Co., New York
Wolverine Tube Div., Detroit

TUBES—Porous for Filtration and Diffusion [498]
Carborundum Co., Perth Amboy, N. J.
Eberbach & Son Co., Ann Arbor, Mich.
Moraine Products Div., Dayton, O.
National Carbon Co., Inc., Cleveland
National Carbon Co., Inc., New York
Norton Co., Worcester, Mass.

TUBES—Thermocouple Protection [499]
Alloy Casting Co., Champaign, Ill.
Acme Foundry Co., Detroit
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
A. M. Byers Co., Pittsburgh
Carborundum Co., Perth Amboy, N. J.
Chicago Steel Foundry Co., Chicago, Ill.
Corning Glass Works, Corning, N. Y.
Driver-Harris Co., Harrison, N. J.
Duraloy Co., Scottdale, Pa.
Electro Ref. & Alloys Corp., Buffalo
Charles Englehard, Inc., Newark, N. J.
Foxboro Co., Foxboro, Mass.
General Alloys Co., Boston, Mass.
Claud S. Gordon Co., Chicago, Ill.
Hoskins Mfg. Co., Detroit, Mich.
Leeds & Northrup Co., Philadelphia, Pa.
Michiana Prod. Corp., Michigan City, Ind.
Michigan Steel Casting Co., Detroit
Norton Co., Worcester, Mass.
Arklay S. Richards Co., Inc., Newton Highlands, Mass.
Pressed Steel Co., Wilkes-Barre, Pa.
E. H. Sargent & Co., Chicago
Summerill Tubing Co., Bridgeport, Pa.
Thermal Syndicate, Ltd., New York
Thwing-Albert Instr. Co., Philadelphia
Wheelco Instrument Co., Chicago, Ill.

TUBES—Stainless [500]
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Carpenter Steel Co., Reading, Pa.
Duraloy Co., Scottdale, Pa.
Michigan Steel Casting Co., Detroit
Michigan Steel Tube Products Co., Detroit
Pittsburgh Steel Co., Pittsburgh, Pa.
Pressed Steel Co., Wilkes-Barre, Pa.
Republic Steel Corp., Cleveland
Summerill Tubing Co., Bridgeport, Pa.
Superior Tube Co., Norristown, Pa.
Timken Roller Bearing Co., Canton, O.
Tube Reducing Corp., Wallington, N. J.

TUBING—Fabricated [501]
Alloy Mfg. Co., Pittsburgh, Pa.
Aluminum Co. of Amer., Pittsburgh, Pa.
Bell & Gossett Co., Morton Grove, Ill.
Bundy Tubing Co., Detroit
Burgess-Parr Co., Freeport, Ill.
Carpenter Steel Co., Welded Alloy Tube Div., Reading, Pa.
Duraloy Co., Scottdale, Pa.
Claud S. Gordon Co., Chicago, Ill.
Haynes Stellite Co., Kokomo, Ind.
Clayton Mark & Co., Evanston, Ill.
Metal Forming Corp., Elkhart, Ind.
Michigan Steel Tube Products Co., Detroit
Mueller Brass Co., Port Huron, Mich.
National Tube Co., Pittsburgh, Pa.
Ohio Seamless Tube Co., Shelby, Ohio
Parker Appliance Co., Cleveland, Ohio
Penn. Flexible Metallic Tubing Co., Phila.
Pittsburgh Tube Co., Pittsburgh
Republic Steel Corp., Cleveland
Revere Copper & Brass Co., New York
Summerill Tubing Co., Bridgeport, Pa.
Tube Reducing Corp., Newark, N. J.
Tubular Alloy Steel Corp., Gary, Ind.
Van Huffel Tube Corp., Warren, Ohio
Wolverine Tube Div., Detroit

TUBING—Finned [502]
Brown Fintube Co., Elyria, Ohio
Carpenter Steel Co., Reading, Pa.
Chase Brass & Cop. Co., Waterbury, Conn.
Claud S. Gordon Co., Chicago, Ill.
Griscom-Russell Co., New York

See Advertisement of Companies in Bold-Face Type for Further Information

THE KING PORTABLE BRINELL

A HARDNESS TESTER FOR PORTABLE AND STATIONARY USE

Puts an actual load of 3000kg. on a 10 mm. ball.

Throat, 4" deep.
Gap, 10" high.
Weight, 26 lbs.

Can be used in any position—even upside down.

Test head removable for testing larger pieces beyond the capacity of the standard base.

ANDREW KING

NARBERTH, PENNA.

STAINLESS STEEL CASTINGS

Heat and Corrosion Resisting

Durco Quality in stainless steel castings is an efficient combination of "know-how" and complete, modern facilities.

As the pioneer American manufacturer specializing in corrosion-resisting alloys and equipment, we have developed many well-known and widely used alloys.

DURIMET and DURCO ALLOYS

Among these are Durimet T and Durimet 20, nickel-chromium low-carbon (0.07% max.) stainless steels especially suitable for sulphuric acids, caustics and bleach solutions. Also Durco KA2S, KA2SMo and other special austenitic chrome-nickel alloys, which may include special modifying elements.

Widely known, too, are the high-silicon irons, Duriron and Durichlor, possessing greater chemical resistance to more corrosive liquids than any other alloys commercially available.

Three large foundries and two machine shops are completely equipped for producing rough or finished castings to our own or your special specifications.

All work is done under complete metallurgical, foundry and laboratory control.

Let us quote on your requirements in alloy castings.

The DURIRON COMPANY, Inc.

Dayton, Ohio, U. S. A.

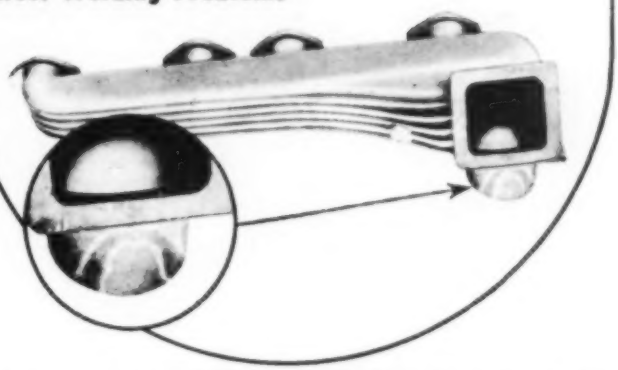
Castolin Eutectic

EUTECTIC*

(Means Lowest Binding Alloy)

LOW TEMPERATURE WELDING

. . . The Answer to Most Welding Problems



NO GENERAL PREHEATING REQUIRED FOR WELDING CAST IRON

PROBLEM

How to repair this cast iron exhaust with a color matching, heat resistant weld? With high temperature, fusion welding there was great risk of stresses, new cracks, and distortion even in the hands of the most skillful welder. Bronze brazing could not be used since the job requires a perfect color match.

SOLUTION

Eutectic Low Temperature Welding Alloy No. 14 was tried. Its low binding temperature (950-1400°F) eliminated risk of stresses, new cracks, and distortion. Many jobs require only slight local preheat • Weld has high heat resistance • Easily machinable • Perfectly color matching.

EUTECTIC LOW TEMPERATURE WELDING ALLOY RODS FOR CAST IRON

Alloy No.	Purpose	Binds at °F	Tensile Strength, Lbs. p.s.i.	Machinable
15	Filling cracks, defects	354° - 600°	1,140 (pressure)	Yes
14	High strength joining	950° - 1400°	48,000	Yes
16	Joining cast iron to steel	1300° - 1600°	117,000	Yes
248	Cast iron not subject to stresses		38,500	Yes
24	Cast iron subject to stresses		20-30,000	Yes

For oxy-acetylene: Eutectic Nos. 14, 15, 16. For AC-DC Metallic Arc: Eutectic Nos. 24, 248.

Chart of 43 Eutectic Alloys for every metal and every welding job available free upon request.

36 PAGE "KNOW-HOW" MANUAL M —WRITE TODAY!

Tells How Eutectic Can Help You!

Contains vital facts on design simplification • Joining dissimilar metals and gauges • Reclaiming delicate castings • Salvaging scarce tools • etc. *Reg. U. S. Pat. Off.

EUTECTIC WELDING ALLOYS COMPANY

Originators of the Low-Temperature Welding Process

40 WORTH STREET, NEW YORK 13, N.Y.

Revere Copper & Brass Co., New York
Wolverine Tube Div., Detroit

TUBING—Seamless Mech., Alloy [503]
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Aluminum Co. of America, Pittsburgh, Pa.
American Brass Co., Waterbury, Conn.
Babcock & Wilcox Tube Co., Beaver Falls, Pa.
Columbia Steel Co., San Francisco, Calif.
Driver-Harris Co., Harrison, N. J.
Duraloy Co., Scottdale, Pa.
Faitoute Iron & Steel Co., Newark, N. J.
Peter A. Frasse & Co., Inc., New York
Globe Steel Tubes Co., Milwaukee, Wis.
Claud S. Gordon Co., Chicago, Ill.
Haynes Stellite Co., Kokomo, Ind.
W. J. Holliday & Co., Hammond, Ind.
International Nickel Co., New York
Mich. Seamless Tube Co., S. Lyon, Mich.
National Tube Co., Pittsburgh, Pa.
Ohio Seamless Tube Co., Shelby, Ohio
Pittsburgh Steel Co., Pittsburgh, Pa.
Revere Copper & Brass Co., New York
Reynolds Metals Co., Louisville, Ky.
Jos. T. Ryerson & Son, Inc., Chicago
SKF Steels, Inc., New York City
Summerill Tubing Co., Bridgeport, Pa.
Superior Tube Co., Norristown, Pa.
Timken Roller Bearing Co., Canton, O.
Tube Reducing Corp., Wallington, N. J.
Tubular Alloy Steel Corp., Gary, Ind.
Edgar T. Ward's Sons Co., Pittsburgh
Whitehead Metal Products Co., New York

TUBING—Welded Mechanical & Stainless [504]
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Alloy Casting Co., Champaign, Ill.
Alloy Mfg. Co., Pittsburgh, Pa.
Babcock & Wilcox Co., New York
Bundy Tubing Co., Detroit
Carpenter Steel Co., Welded Alloy Tube Div., Reading, Pa.
Columbia Steel Co., San Francisco, Ca
Driver- Harris Co., Harrison, N. J.
Peter A. Frasse & Co., Inc., New York
General Alloys Co., Boston, Mass.
Globe Steel Tubes Co., Milwaukee, Wi
Laclede Steel Co., St. Louis, Mo.
Clayton Mark & Co., Evanston, Ill.
Metal Forming Corp., Elkhart, Ind.
Michigan Steel Casting Co., Detroit
Michigan Steel Tube Products Co., Det
Molybdenum Corp. of America, Pittsbu
National Tube Co., Pittsburgh, Pa.
Ohio Seamless Tube Co., Shelby, Ohio
Penn. Flexible Metallic Tubing Co., P
Pittsburgh Tube Co., Pittsburgh
Pressed Steel Co., Wilkes-Barre, Pa.
Republic Steel Corp., Cleveland, Ohio
Jos. T. Ryerson & Son, Inc., Chicago
Superior Tube Co., Norristown, Pa.
Tube Reducing Corp., Wallington, N.
Tubular Alloy Steel Corp., Gary, Ind.
Van Huffel Tube Corp., Warren, Ohio
Edgar T. Ward's Sons Co., Pittsburgh
Yoder Co., Cleveland, Ohio

TUMBLING BARRELS—See Barrels

TUNGSTEN [505]
Electro Metallurgical Co., New York
P. R. Mallory & Co., Inc., Indianapo
Molybdenum Corp. of Amer., Pittsbu
Reduction & Refining Co., Newark, N.

TUNGSTEN CARBIDE [506]
Firth-Sterling Steel Co., McKeesport,
Foote Mineral Co., Philadelphia, Pa.
Haynes Stellite Co., Kokomo, Ind.
Lincoln Park Tool & Gage Co., Lin
Park, Mich.
Molybdenum Corp. of Amer., Pittsbu
Stoody Co., Whittier, Cal.
Tungsten Elec., Corp., Union City, N.
Vascoloy-Ramet Corp., North Chicago
Willey's Carbide Tool Co., Detroit

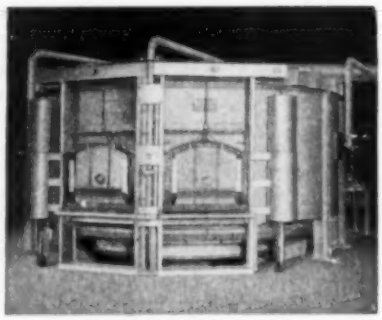
TURBO-COMPRESSORS [507]
Amer. Gas Furnace Co., Elizabeth, N.
Chicago Flexible Shaft Co., Chicago,
Claud S. Gordon Co., Chicago, Ill.
Ingersoll-Rand Co., Phillipsburg, N. J.
Spencer Turbine Co., Hartford, Conn.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia

UNIT HEATERS—See Heaters—Unit

UPSETTING MACHINES—See For Machines

VALVES [508]
Amer. Steel Foundries, Chicago
Baldwin Southwark Div., Baldwin L motive Works, Philadelphia, Pa.
Bastian Blessing Co., Chicago, Ill.
Bell & Gossett Co., Morton Grove, Ill.
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia,
Brown-Wales Co., Boston, Mass.
Chapman Valve Mfg. Co., Indian chard, Mass.
Chase Brass & Cop. Co., Waterbury, C
Eclipse Fuel Engrg. Co., Rockford, Ill.
Elmes Engineering Works of Amer Steel Foundries, Chicago, Ill.
Foxboro Co., Foxboro, Mass.
Claud S. Gordon Co., Chicago, Ill.
Hammond Brass Works, Hammond, I
Hannifin Manufacturing Co., Chicago
Hauck Mfg. Co., Brooklyn, N. Y.
Hydraulic Press Mfg. Co., Mt. Gilead,
Hydro-Power Systems, Inc., Mt. Gilea
Koppers Co., Pittsburgh, Pa.
Lebanon Steel F'dry, Lebanon, Pa.
Mahr Manufacturing Co., Minneapoli
Manning, Maxwell & Moore, Bridge Conn.
Mesta Machine Co., Pittsburgh, Pa.
National Carbon Co., Inc., New York
National Machine Works, Chicago
North American Mfg. Co., Cleveland
Ohio Steel Foundry Co., Springfield,
Parker Appliance Co., Cleveland, Ohi
R-S Products Corp., Philadelphia, Pa.
W. S. Rockwell Co., New York
Reading-Pratt & Cady Div., Amer Chain & Cable Co., Inc., Reading,
Reed Roller Bit Co., Houston, Tex.
Stow Mfg. Co., Binghamton, N. Y.
C. J. Tagliabue Mfg. Co., Brooklyn,
Tate-Jones & Co., Inc., Leetsdale, Pa.
Taylor Instrument Co's., Rochester,
U. S. Steel Supply Co., Chicago
Wheelco Instruments Co., Chicago, Ill.

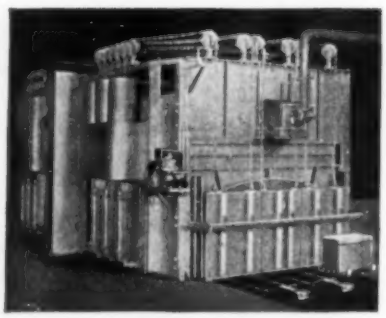
SAFETY THE JOHNSTON LINE DEPENDABILITY



ROTATING

JOHNSTON FURNACES

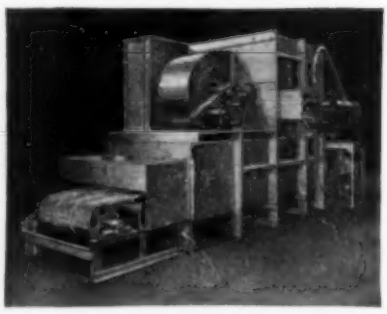
"TAILOR MADE" TO YOUR NEEDS



PUSHER

A TYPE FOR EVERY HEAT TREATING PURPOSE

Highest Efficiency and Greatest Economy assured by



CONTINUOUS

JOHNSTON
REVERSE BLAST OIL or GAS
BURNERS
DIRECT CONNECTED PRESSURE
BLOWERS
VALVELESS AUTOMATIC
CONTROLLERS

JOHNSTON
MANUFACTURING COMPANY
MINNEAPOLIS, MINNESOTA

ALVES—Corrosion-Resisting [509]
oy Casting Co., Champaign, Ill.
oy Steel Products Co., Linden, N. J.
erican Hard Rubber Co., New York
er. Mang. Steel Div., American Brake Shoe Co., Chicago Hts.
wn Instrument Co., Philadelphia, Pa.
wn-Wales Co., Boston, Mass.
apman Valve Mfg. Co., Indian Orchard, Mass.
icago Steel Foundry Co., Chicago
t.-Diamond Fibre Co., Newark, Del.
per Alloy F'dry Co., Hillside, N. J.
ver-Harris Co., Harrison, N. J.
raloy Co., **Scottdale, Pa.**
riron Co., **Inc., Dayton, O.**
neral Alloys Co., Boston, Mass.
reg Corp., Newark, Delaware
anon Steel Foundry, Lebanon, Pa.
hiana Prod. Corp., Michigan City, Ind.
higan Steel Casting Co., Detroit
tional Carbon Co., Inc., New York
io Steel Foundry Co., Springfield, Ohio
S Products Corp., Philadelphia, Pa.
ading-Pratt & Cady Division, American Chain & Cable Co., Inc., Reading, Pa.
le-Jones & Co., Inc., Leetsdale, Pa.
S Stoneware Co., Akron, Ohio
rthington Pump & Machinery Corp., Harrison, N. J.

ALVES—Motor Operated [510]
tomatic Temp. Control, Inc., Phila.
rber-Colman Co., Rockford, Ill.
ll & Gossett Co., Morton Grove, Ill.
stol Co., Waterbury, Conn.
wn Instrument Co., Philadelphia, Pa.
apman Valve Mfg. Co., Indian Orchard, Mass.
ler-Hammer, Inc., Milwaukee, Wis.
nboro Co., Foxboro, Mass.
neral Controls Co., Glendale, Calif.
ud S. Gordon Co., Chicago, Ill.
arles A. Martin Co., Chicago
mon Premix Burner Co., Muncie, Ind.
rth American Mfg. Co., Cleveland
S Products Corp., Philadelphia, Pa.
ading-Pratt & Cady Division, American Chain & Cable Co., Inc., Reading, Pa.
ican Corp., Philadelphia
helco Instruments Co., Chicago, Ill.

NADIUM [511]
ctro Metallurgical Co., New York**
te Mineral Co., Philadelphia, Pa.
nadium Corp. of America, New York

NTILATING EQUIPMENT [512]
erican Blower Corp., Detroit
er. F'dry Equip. Co., Mishawaka, Ind.
c-Mayer Corp., Cleveland, O.
Rothezat Vent. Equip. Div., Amer. Mach. & Metals, Inc., E. Moline, Ill.
spatch Oven Co., Minneapolis, Minn.
ustrial Oven Engr. Co., Cleveland
frey Mfg. Co., Columbus, Ohio
e Safety Appliances Co., Pittsburgh
sara Blower Co., New York
sche Airbrush Co., Chicago, Ill.
rsons Engr. Corp., Cleveland, Ohio**
ele Testing Machine Div., American Machine & Metals, Inc., E. Moline, Ill.
ude B. Schneible Co., Chicago
le-Jones & Co., Inc., Leetsdale, Pa.

BRATING SCREENS—Wire [513]
ur Flex. Coupling Co., Westfield, N. Y.
tchon Wire Cloth Corp., Philadelphia
frey Mfg. Co., Columbus, Ohio
llow-Saylor Wire Co., St. Louis
ur Manufacturing Co., Minneapolis
wark Wire Cloth Co., Newark, N. J.
ins Conveyors, Inc., Passaic, N. J.
phens-Adamson Mfg. Co., Aurora, Ill.

SHING MACH.—Industrial [514]
ley-Ferguson Co., Cincinnati, Ohio
er. F'dry Equip. Co., Mishawaka, Ind.
S. Blakeslee & Co., Chicago, Ill.
o Products Co., Cleveland
t's Patent Fire Arms Mfg. Co., Hartford, Conn.
rex Corp., Detroit
d Floor Machine Co., Chicago, Ill.
ward Engrg. & Mfg. Co., Cincinnati
acDermid, Inc., Waterbury, Conn.**
gnus Chem. Co., Garwood, N. J.
alwash Machinery Co., Newark, N. J.
alwash Machinery Co., Irvington, N. J.
rsons Engineering Corp., Cleveland**
Ransohoff, Inc., Cincinnati, Ohio**
ele Testing Machine Div., American Machine & Metals, Inc., E. Moline, Ill.
Solventol Chemical Products, Inc., Detroit
Tate-Jones & Co., Inc., Leetsdale, Pa.

WELDER CONTROL—For Spot, Butt, Projection Welding Machines [515]
Air Reduction, New York
Callite Tungsten Corp., Union City, N. J.
Clark Controller Co., Cleveland, Ohio
Elec. Controller & Mfg. Co., Cleveland
Federal Machine & Welder Co., Warren, O.
General Electric Co., Schenectady, N. Y.
Hercules Elec. & Mfg. Co., Brooklyn
Nat'l Time & Signal Corp., Detroit
Pier Equip. Mfg. Co., Benton Harbor, Mich.
Universal Power Corp., Cleveland
Weltronic Corp., Detroit
Westinghouse Electric & Mfg. Co., E. Pgh.

WELDING CARBON—Plates, Rods, Paste [516]
Air Reduction, New York
American Agile Corp., Cleveland
Int. Graphite & Electrode Corp., St. Marys, Pa.
National Carbon Co., Inc., Cleveland
National Carbon Co., Inc., New York
National Cylinder Gas Co., Chicago
Ohio Carbon Co., Cleveland, Ohio
U. S. Graphite Co., Saginaw, Mich.
Universal Power Corp., Cleveland
Whitehead Metal Products Co., New York

WELDING—Electric [517]
Air Reduction, New York
Allied Weld-craft, Inc., Indianapolis, Ind.
American Agile Corp., Cleveland
American Bridge Co., Pittsburgh, Pa.
Arcos Corp., Philadelphia, Pa.
Baldwin Locomotive Works, Philadelphia
Cullen-Friestedt Co., Chicago
Eisler Engineering Co., Newark, N. J.
Electric Arc, Inc., Newark, N. J.
Ergolyte Mfg. Co., Philadelphia
Farrel-Birmingham Co., Ansonia, Conn.
General Electric Co., Schenectady, N. Y.
Greyhound Elec. Mfg. Co., Inc., Brooklyn
Harnischfeger Corp., Milwaukee, Wis.
Hercules Elec. & Mfg. Co., Brooklyn
Hobart Brothers Co., Troy, Ohio
L. O. Koven & Bro., Inc., Jersey City, N. J.
K. O. Lee Co., Aberdeen, South Dakota
Lincoln Electric Co., Cleveland
Linde Air Products Co., New York
Lukens Steel Co.; ByProducts Steel Corp.; Lukenweld, Inc., Coatesville, Pa.
Lukenweld, Inc., Coatesville, Pa.
Marquette Mfg. Co., Inc., Minneapolis
Maurath, Inc., Cleveland, Ohio
Nat'l Cylinder Gas Co., Chicago
Nat'l Time & Signal Corp., Detroit
Horace T. Potts Co., Philadelphia, Pa.
Sperry Products, Inc., Hoboken, N. J.
Stanwood Corp., Chicago
Stearns-Roger Mfg. Co., Denver, Colo.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Taylor-Hall Weld. Corp., Worcester, Mass.
Universal Power Corp., Cleveland
Welding Machines Mfg. Co., Detroit
Westinghouse Electric & Mfg. Co., E. Pgh.
Wilson Welder & Metals Co., New York

WELDING & CUTTING MACHINES EQUIPMENT—Oxy-Acetylene [518]
Air Reduction, New York
Bastian-Blessing Co., Chicago
Dockson Corp., Detroit
Ergolyte Mfg. Co., Philadelphia
General Welding & Equip. Co., Boston
Harris Calorific Co., Cleveland, Ohio
Hobart Bros. Co., Troy, Ohio
Linde Air Products Co., New York
Modern Engineering Co., St. Louis, Mo.
National Cylinder Gas Co., Chicago
Smith Welding Equipment Corp., Minneapolis, Minn.
Tolman Mfg. Co., South Boston, Mass.
Universal Power Corp., Cleveland
Victor Equip. Co., San Francisco, Calif.

WELDING ELECTRODES—See Electrodes

WELDING FIXTURES [519]
Air Reduction, New York
Algoma Products, Detroit, Mich.
American Brass Co., Waterbury, Conn.
Ergolyte Mfg. Co., Philadelphia
Lukens Steel Co., Coatesville, Pa.
National Cylinder Gas Co., Chicago
Parsons Engineering Corp., Cleveland
Progressive Welder Co., Detroit
Ransome Concrete Machinery Co., Dunellen, N. J.
Service Machine Co., Elizabeth, N. J.
Welding Machines Mfg. Co., Detroit

WELDING FUME COLLECTORS [520]
Claude B. Schneible Co., Chicago
Torit Mfg. Co., St. Paul, Minn.
Universal Power Corp., Cleveland
Westinghouse Elec. & Mfg. Co., E. Pgh., Pa.

WELDING MACHINES—Butt [521]
Air Reduction, New York
Eisler Engineering Co., Newark, N. J.
Federal Machine & Welder Co., Warren, O.
Linde Air Products Co., New York
National Electric Welding Machines Co., Bay City, Mich.
Sciaky Bros., Chicago
Taylor-Hall Welding Corp., Worcester, Mass.
Thomson-Gibb Elec. Welding Co., Lynn, Mass.
Universal Power Corp., Cleveland
Welding Machines Mfg. Co., Detroit

WELDING MACHINES—Elec. Arc [522]
Air Reduction, New York
Allied Weld-craft, Inc., Indianapolis, Ind.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Arcos Corp., Philadelphia, Pa.
Emerson Elec. Mfg. Co., St. Louis
Ergolyte Mfg. Co., Philadelphia
General Electric Co., Schenectady, N. Y.
Glenn-Roberts Co., Oakland, Calif.
Greyhound Elec. Mfg. Co., Inc., Brooklyn
Hercules Elec. & Mfg. Co., Brooklyn
K. O. Lee Co., Aberdeen, S. D.
Lincoln Electric Co., Cleveland, Ohio
Linde Air Products Co., New York
Marquette Mfg. Co., Inc., Minneapolis
Miller Elec. Mfg. Co., Appleton, Wis.
National Cylinder Gas Co., Chicago
Pier Equip. Mfg. Co., Benton Harbor, Mich.
Sight Feed Generator Co., Richmond, Ind.
A. O. Smith Corp., Milwaukee, Wis.
Smith Welding Equipment Corp., Minneapolis, Minn.
U. S. Steel Supply Co., Chicago
Universal Power Corp., Cleveland
Westinghouse Electric & Mfg. Co., E. Pgh.
Wilson Welder & Metals Co., New York

WELDING MACHINES—Flash [523]
Arcos Corp., Philadelphia, Pa.
Federal Machine & Welder Co., Warren, O.
National Electric Welding Machines Co., Bay City, Mich.
Progressive Welder Co., Detroit
Sciaky Bros., Chicago
Sperry Products, Inc., Hoboken, N. J.
Taylor-Hall Welding Corp., Worcester Mass.
Taylor-Winfield Corp., Warren, Ohio
Thomson-Gibb Elec. Welding Co., Lynn, Mass.
Universal Power Corp., Cleveland
Welding Machines Mfg. Co., Detroit

WELDING MACHINES—Press [524]
Arcos Corp., Philadelphia, Pa.
Federal Machine & Welder Co., Warren, O.
National Electric Welding Machines Co., Bay City, Mich.
Pier Equip. Mfg. Co., Benton Harbor, Mich.
Progressive Welder Co., Detroit
Sciaky Bros., Chicago, Ill.
Taylor-Hall Welding Corp., Worcester Mass.
Taylor-Winfield Corp., Warren, Ohio
Universal Power Corp., Cleveland
Welding Machines Mfg. Co., Detroit

WELDING MACHINES—Resistance [525]
Arcos Corp., Philadelphia, Pa.
Federal Machine & Welder Co., Warren, O.
Pier Equip. Mfg. Co., Benton Harbor, Mich.
Sciaky Bros., Chicago, Ill.
Taylor-Hall Welding Corp., Worcester, Mass.
Taylor-Winfield Corp., Warren, Ohio
Thomson-Gibb Electric Welding Co., Lynn, Mass.
Universal Power Corp., Cleveland
Welding Machines Mfg. Co., Detroit

WELDING MACHINES—Seam [526]
Arcos Corp., Philadelphia, Pa.
Federal Machine & Welder Co., Warren, O.
National Electric Welding Machines Co., Bay City, Mich.
Progressive Welder Co., Detroit
Sciaky Bros., Chicago, Ill.
Thomson-Gibb Electric Welding Co., Lynn, Mass.
Universal Power Corp., Cleveland
Welding Machines Mfg. Co., Detroit

WELDING MACHINES—Spot [527]
Arcos Corp., Philadelphia, Pa.

Eisler Engineering Co., Newark, N. J.
Federal Machine & Welder Co., Warren, O
Hercules Elec. & Mfg. Co., Brooklyn
National Electric Welding Machines Co., Bay City, Mich.
Pier Equip. Mfg. Co., Benton Harbor, Mich.
Progressive Welder Co., Detroit
Sciaky Bros., Chicago, Ill.
Taylor-Hall Welding Corp., Worcester, Mass.
Taylor-Winfield Corp., Warren, Ohio
Thomson-Gibb Electric Welding Co., Lynn, Mass.
Universal Power Corp., Cleveland
Welding Machines Mfg. Co., Detroit

WELDING POSITIONERS [528]
Air Reduction, New York
Cullen-Friestedt Co., Chicago
Dockson Corp., Detroit
Electric Arc, Inc., Newark, N. J.
Hercules Elec. & Mfg. Co., Brooklyn, N. Y.
Lincoln Electric Co., Cleveland, Ohio
Lukenweld, Inc., Coatesville, Pa.
Lyon-Raymond Corp., Greene, N. Y.
Parsons Engineering Corp., Cleveland
Ransome Concrete Machinery Co., Dunellen, N. J.
Universal Power Corp., Cleveland

WELDING RODS & FLUXES—See Rods—Welding

WIDE FIELD BINOCULAR MICROSCOPES—See Metallurgical Microscopes

WIRE [529]
Acme Steel Co., Chicago
Aluminum Co. of America, Pittsburgh, Pa.
American Brass Co., Waterbury, Conn.
Amer. Electro Metal Corp., Yonkers, N. Y.
American Steel & Wire, Cleveland, Ohio
Bethlehem Steel Co., Bethlehem, Pa.
Callite Tungsten Corp., Union City, N. J.
Carpenter Steel Co., Reading, Pa.
Chase Brass & Cop. Co., Waterbury, Conn.
Columbia Steel Co., San Francisco, Calif
Continental Steel Corp., Kokomo, Ind.
Copperweld Steel Co., Glassport, Pa.
Cuyahoga Steel & Wire Co., Cleveland
Wilbur B. Driver Co., Newark, N. J.
Driver-Harris Co., Harrison, N. J.
Firth-Sterling Steel Co., McKeesport, Pa.
Laclede Steel Co., St. Louis, Mo.
Page Steel & Wire Div., American Chain & Cable Co., Monessen, Pa.
Pittsburgh Steel Co., Pittsburgh, Pa.
A. B. & J. Rathbone, Palmer, Mass.
Republic Steel Corp., Cleveland, Ohio
Revere Copper & Brass, Inc., New York
Riverside Metal Co., Riverside, N. J.
Jos. T. Ryerson & Son, Inc., Chicago
Seneca Wire & Mfg. Co., Fostoria, Ohio
Charles G. Stevens Co., Chicago, Ill.
Tenn. Coal, Iron & R.R. Co., Birm., Ala.
Timken Roller Bearing Co., Canton, O.
U. S. Steel Supply Co., Chicago
Univ.-Cyclops Steel Corp., Bridgeville, Pa.
Edgar T. Ward's Son Co., Philadelphia
Whitehead Metal Products Co., New York
Wickwire Brothers, Inc., Cortland, N. Y.
Wickwire Spencer Steel Co., New York

WIRE—Alloy [530]
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
Alloy Casting Co., Champaign, Ill.
Aluminum Co. of America, Pittsburgh, Pa.
American Brass Co., Waterbury, Conn.
American Steel & Wire, Cleveland, Ohio
Bethlehem Steel Co., Bethlehem, Pa.
Callite Tungsten Corp., Union City, N. J.
Carpenter Steel Co., Reading, Pa.
Chase Brass & Cop. Co., Waterbury, Conn.
John Chatillon & Sons, New York, N. Y.
Columbia Steel Co., San Francisco, Calif.
Wilbur B. Driver Co., Newark, N. J.
Driver-Harris Co., Harrison, N. J.
Firth-Sterling Steel Co., McKeesport, Pa.
General Alloys Co., Boston, Mass.
Claud S. Gordon Co., Chicago, Ill.
Haynes Stellite Co., Kokomo, Ind.
Hoskins Mfg. Co., Detroit, Mich.
C. O. Jelliff Mfg. Corp., Southport, Conn.
J. M. Ney Co., Hartford, Conn.
North American Philips Co., New York
Page Steel & Wire Div., American Chain & Cable Co., Monessen, Pa.
Republic Steel Corp., Cleveland, Ohio
Revere Copper & Brass, Inc., New York
Tenn. Coal, Iron & R. R. Co., Birm., Ala.
Timken Roller Bearing Co., Canton, O.
Univ.-Cyclops Steel Corp., Bridgeville, Pa.
Whitehead Metal Products Co., New York

WIRE—Aluminum [531]
Aluminum Co. of America, Pittsburgh, Pa.
Callite Tungsten Corp., Union City, N. J.
Wilbur B. Driver Co., Newark, N. J.
Reynolds Metals Co., Louisville, Ky.
Whitehead Metal Products Co., New York

WIRE—Brass & Bronze [532]
American Brass Co., Waterbury, Conn.
Bridgeport Brass Co., Bridgeport, Conn.
Callite Tungsten Corp., Union City, N. J.
Chase Brass & Cop. Co., Waterbury, Conn.
Wilbur B. Driver Co., Newark, N. J.
C. O. Jelliff Mfg. Corp., Southport, Conn.
Revere Copper & Brass, Inc., New York
Riverside Metal Co., Riverside, N. J.
Whitehead Metal Products Co., New York

WIRE—Heat Resisting [533]
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
American Brass Co., Waterbury, Conn.
Amer. Steel & Wire Co., Cleveland
Callite Tungsten Corp., Union City, N. J.
G. O. Carlson, Inc., Thorndale, Pa.
Carpenter Steel Co., Reading, Pa.
Wilbur B. Driver Co., Newark, N. J.
Driver-Harris Co., Harrison, N. J.
Firth-Sterling Steel Co., McKeesport, Pa.
Peter A. Frasse & Co., Inc., New York
General Alloys Co., Boston, Mass.
Claud S. Gordon Co., Chicago, Ill.
Haynes Stellite Co., Kokomo, Ind.
Hoskins Mfg. Co., Detroit
Industrial Steels, Inc., Cambridge, Mass.
International Nickel Co., New York, N. Y.
C. O. Jelliff Mfg. Corp., Southport, Conn.
Ohio Steel Foundry Co., Springfield, Ohio
Republic Steel Corp., Cleveland
Rustless Iron & Steel Corp., Balt., Md.
Sterling-Alloys, Inc., Woburn, Mass.
Timken Roller Bearing Co., Canton, O.

WIRE MAKING MACHINERY & EQUIPMENT [534]
Ajax Mfg. Co., Cleveland, Ohio
E. W. Bliss Co., Brooklyn, N. Y.
Callite Tungsten Corp., Union City, N. J.
Continental Industrial Engineers, Chicago
Fidelity Mach. Co., Philadelphia
Hydropress, Inc., New York
Industrial Oven Engr. Co., Cleveland
Morrison Engr. Co., Inc., Cleveland, Ohio
Moslo Machinery Co., Cleveland
F. B. Shuster Co., New Haven, Conn.
Sleeper & Hartley, Worcester, Mass.
Standard Machinery Co., Providence, R. I.
Vaughn Mach. Co., Cuyahoga Falls, O.

WIRE BELTS & CLOTH [535]
Audubon Wire Cloth Corp., Philadelphia
Buffalo Wire Works Co., Buffalo, N. Y.
Chase Brass & Cop. Co., Waterbury, Conn.
Cyclone Fence Div., Amer. Steel & Wire Co., Waukegan, Ill.
Driver-Harris Co., Harrison, N. J.
Logan Co., Louisville, Ky.
Newark Wire Cloth Co., Newark, N. J.
Rolock, Inc., Fairfield, Conn.
Tate-Jones & Co., Inc., Leetsdale, Pa.
Vulcan Corp., Philadelphia
Whitehead Metal Products Co., New York

WIRE DRAWING LUBRICANTS [536]
E. F. Houghton & Co., Philadelphia
Magnus Chem. Co., Inc., Garwood, N. J.

WIRE—Stainless [537]
Allegheny Ludlum Steel Corp., Brackenridge, Pa.
American Steel & Wire, Cleveland, Ohio
Arcos Corp., Philadelphia, Pa.
Callite Tungsten Corp., Union City, N. J.
G. O. Carlson, Inc., Thorndale, Pa.
Carpenter Steel Co., Reading, Pa.
Columbia Steel Co., San Francisco, Calif.
Wilbur B. Driver Co., Newark, N. J.
Driver-Harris Co., Harrison, N. J.
Firth-Sterling Steel Co., McKeesport, Pa.
Peter A. Frasse & Co., Inc., New York
General Alloys Co., Boston, Mass.
Ideal Commutator Dresser Co., Sycamore, Ill.
Page Steel & Wire Div., American Chain & Cable Co., Monessen, Pa.
Pittsburgh Steel Co., Pittsburgh, Pa.
Republic Steel Corp., Cleveland
Rustless Iron & Steel Corp., Balt., Md.
Jos. T. Ryerson & Son, Inc., Chicago
Univ.-Cyclops Steel Corp., Bridgeville, Pa.

WIRE STRAIGHTENING & CUTTING MACHINES [538]
Callite Tungsten Corp., Union City, N. J.
Electric Arc, Inc., Newark, N. J.
Fidelity Machine Co., Philadelphia
Hydropress, Inc., New York
Lewis Machine Co., Cleveland
Moslo Machinery Co., Cleveland
F. B. Shuster Co., New Haven, Conn.
Sleeper & Hartley, Worcester, Mass.

WIRE TESTING MACHINES [539]
Amthor Testing Inst. Co., Inc., Brooklyn
Baldwin Southwark Div., Baldwin Locomotive Works, Philadelphia, Pa.
W. C. Dillon & Co., Inc., Chicago
Fidelity Machine Co., Philadelphia
General Electric Co., Schenectady, N. Y.
Krouse Testing Machine Co., Columbus, O.
Tinius Olsen Testing Machine Co., Phila.
Riehle Testing Machine Div., American Mach. & Metals, Inc., East Moline, Ill.
Steel City Testing Lab., Detroit, Mich.
Taber Instr. Co., N. Tonawanda, N. Y.

WIRE—Welding [540]
Allied Weld-craft, Inc., Indianapolis, Ind.
Aluminum Co. of America, Pittsburgh, Pa.
American Agile Corp., Cleveland
American Brass Co., Waterbury, Conn.
Arcos Corp., Philadelphia, Pa.
Bethlehem Steel Co., Bethlehem, Pa.
Bridgeport Brass Co., Bridgeport, Conn.
Carpenter Steel Co., Reading, Pa.
Chase Brass & Cop. Co., Waterbury, Conn.
Wilbur B. Driver Co., Newark, N. J.
Eutectic Welding Alloys, Inc., New York
General Electric, Schenectady, N. Y.
Hoskins Mfg. Co., Detroit, Mich.
Laclede Steel Co., St. Louis, Mo.
Lincoln Electric Co., Cleveland
Linde Air Products Co., New York
Maurath, Inc., Cleveland, Ohio
National Cylinder Gas Co., Chicago
Page Steel & Wire Div., American Chain & Cable Co., Monessen, Pa.
Pittsburgh Steel Co., Pittsburgh, Pa.
Horace T. Potts Co., Philadelphia, Pa.
Jos. T. Ryerson & Son, Inc., Chicago
Titan Metal Mfg. Co., Bellefonte, Pa.
U. S. Steel Supply Co., Chicago
Universal Power Corp., Cleveland
Westinghouse Electric & Mfg. Co., E. Pgh.
Whitehead Metal Products Co., New York
Wickwire Spencer Steel Co., New York
Youngstown Sheet & Tube Co., Youngstown, O.

X-RAY APPARATUS [541]
American Inst. Co., Silver Spring, Md.
Canadian Radium & Uranium Corp., N. Y.
General Electric X-Ray Corp., Chicago
Hercules Elec. & Mfg. Co., Brooklyn, N. Y.
Adam Hilger, Ltd., London, England
Jarrell-Ash Co., Boston, Mass.
Kelley-Koett Mfg. Co., Covington, Ky.
North American Philips Co., New York
Picker X-Ray Corp., New York
Standard X-Ray Co., Chicago
Westinghouse Electric & Mfg. Co., E. Pgh.
"X-Ray Inc.," Detroit

X-RAY SERVICE [542]
Agfa Ansco, Binghamton, N. Y.
Electro Alloys Co., Elyria, Ohio
Claud S. Gordon Co., Chicago, Ill.
Heilman Boiler Works, Allentown, Pa.
Kelley-Koett Mfg. Co., Covington, Ky.
Standard X-Ray Co., Chicago
Triplett & Barton, Inc., Burbank, Calif.
Westinghouse Electric & Mfg. Co., E. Pgh.

X-RAY SUPPLIES [543]
Agfa Ansco, Binghamton, N. Y.
Callite Tungsten Corp., Union City, N. J.
Eastman Kodak Co., Rochester, N. Y.
General Electric X-Ray Corp., Chicago
Kelley-Koett Mfg. Co., Covington, Ky.
North American Philips Co., New York
Picker X-Ray Corp., New York
Standard X-Ray Co., Chicago
Westinghouse Electric & Mfg. Co., E. Pgh.

ZINC [544]
Anaconda Copper Mining Co., New York
Apex Smelting Co., Chicago
Apollo Metal Works, Chicago, Ill.
Driver-Harris Co., Harrison, N. J.
E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.
Eagle-Picher Sales Co., Cincinnati, O.
Foote Mineral Co., Philadelphia
MacDermid, Inc., Waterbury, Conn.
New Jersey Zinc Co., New York
U. S. Smelting, Ref. & Mining Co., N. Y.
Whitehead Metal Products Co., New York

See Advertisement of Companies in Bold-Face Type for Further Information

East Engin. Library

NEW! The TOCCOTRON

NOT a laboratory instrument but a SHOP TOOL for electronic induction heating

HERE is a NEW electronic tube type induction heating machine—the result of four years' tests and development. It is designed and built to stand the gaff of shop usage. This is another TOCCO *first* for it means that radio frequency induction heating equipment has been taken out of the class of a laboratory instrument and developed into a dependable shop tool for uniform, low-cost production. Note the features of the TOCCOTRON:

RUGGED PRODUCTION MACHINE. Power tubes and contacters are shock-mounted. Fully protected. No radio-frequency radiation. No high voltage hazards. Tube filament voltages are automatically held constant over a wide range of line voltage variations.

A PACKAGED UNIT. Completely self-contained in all-metal cabinet. All sub-assemblies are easily accessible. All timers and necessary controls are integral with the machine, as is the sink type work area.

FASTER. Only electronic tube type induction heating unit with two independently controlled work stations which can be set up for different jobs for operation at same or different frequencies. Convenient control of power output over wide range.

Available in 20 K.W. output with nominal frequency of 450,000 cycles. Typical applications: Small parts . . . hardening, brazing, annealing, heating for forming. Sharp contours such as hardening of cutting edges. Shallow penetration in surface hardening.

Full details in Bul. 20. Consult the TOCCO Engineer for a study of *your* problems in Induction Heating. His analysis is unbiased because TOCCO manufactures both motor-generator and electronic tube types of equipment.

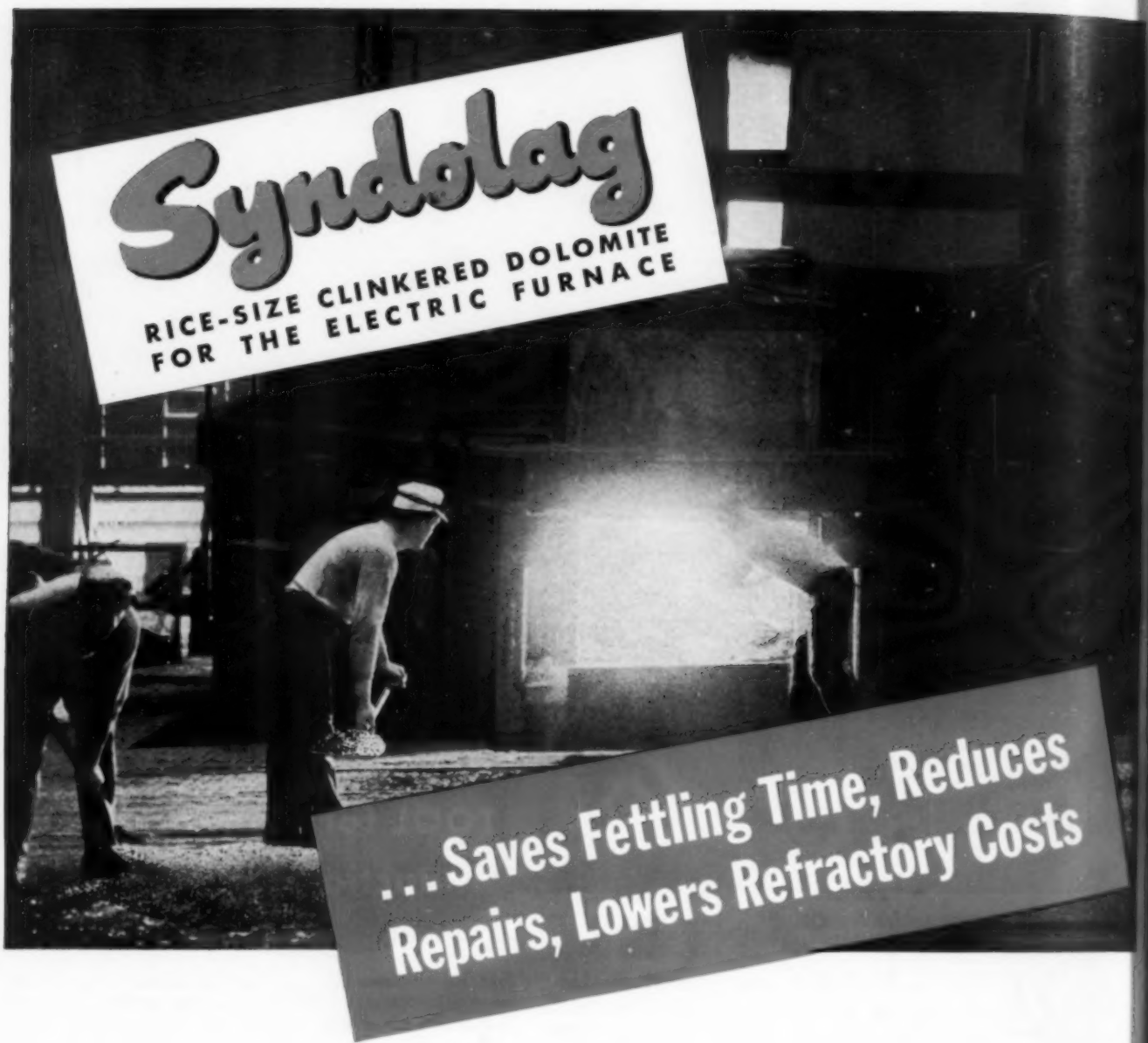
THE OHIO CRANKSHAFT COMPANY • Cleveland 1, Ohio

TOCCO

INDUCTION

HARDENING . . BRAZING

ANNEALING . . HEATING



● Efficient, economical fettling of an electric furnace calls for a smaller-sized refractory than the standard open hearth clinkered dolomite. Syndolag was designed to meet that need. It is a rice-size material, of sharp angled grains, carefully proportioned as to size and free of fines.

Since its introduction in the rice-size two years ago, Syndolag has grown steadily in favor in electric furnace shops. Operators who use it like it for these unique properties:

1. Sharp angle of repose—The small, angular grains stay in place well on steep slopes, instead of rolling down the banks to pile up around the edges of the flat. This cuts down fettling time, reduces refractory consumption and protects the capacity of the furnace.

2. Rapid heat absorption—Small grains absorb heat more quickly than larger grained material. This is especially important in the electric furnace where only residual heat after tapping is available to set a refractory.

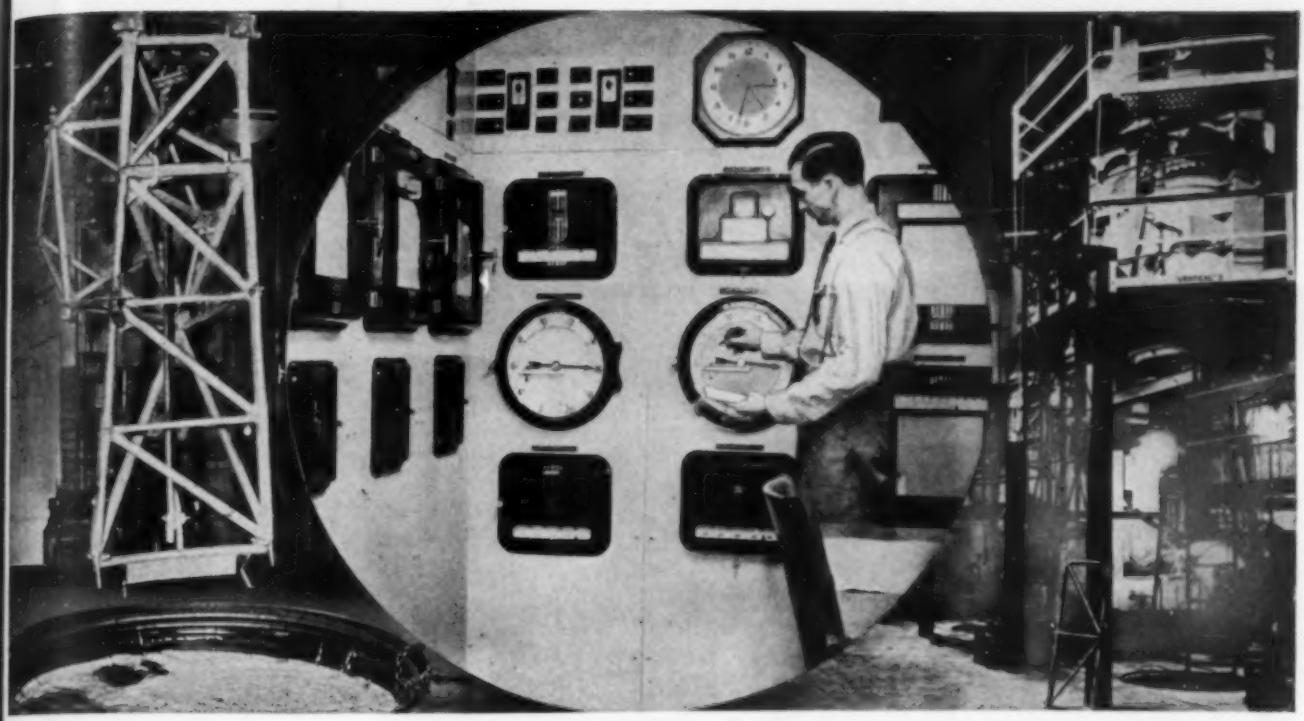
3. Quick consolidation—Syndolag's small grains set up quickly into a dense, homogeneous patch which does not cut out readily or loosen easily—a valuable asset for top charged furnaces.

Syndolag has the same desirable chemical and mineralogical properties that have made Magnefer so successful for open hearth maintenance. Both refractories are produced at our modern plant in Northwestern Ohio, located near the geographical center of the steel industry. Adequate stocks are maintained, so that we can take care of your immediate needs with prompt rail shipments.

BASIC FURNACE
REFRACTORIES

BASIC REFRACTORIES, INCORPORATED *Cleveland, Ohio*

Metal Progress is published and copyrighted, 1944, by American Society for Metals, 7301 Euclid Avenue, Cleveland, Ohio. Issued monthly; subscriptions $5 a year. Entered as second-class matter Feb. 7, 1921, at the post office at Cleveland, Ohio, under the act of March 3, 1879.



Jigged to prevent distortion, this welded member for the nacelle of a Beechcraft plane plunges from an Micromax-controlled vertical furnace into oil quench. Quenching is complete in 5 to 8 seconds.

Beech Aircraft's centralized control room in which are located the Micromax Pyrometers to regulate all heat-treating temperatures. The foreman is consulting the Pyrometer for the vertical nacelle-furnaces.

One of the Micromax-regulated furnaces in which nacelle elements are heated. These furnaces are gas-fired, full muffle, atmosphere-controlled; are specially designed to Beech's needs.

BEECH INCREASES HEAT-TREAT EFFICIENCY By Centralizing Its Micromax Controllers

Heat-treating operations performed in the Beech Aircraft Corp. plant at Wichita, Kansas, include case hardening, annealing, normalizing, stress-relieving, hardening, etc. The job of automatically controlling the temperatures of these operations has been turned over to Micromax Pyrometers, with the result that their micro-responsive control is giving Beech routinely dependable heat-treatment.

For utmost efficiency, instruments are centralized in a specially-designed control room. Here all Micromax Controllers have the same ambient temperatures; all operating conditions are standardized; one man keeps all temperatures under his eye. The room is supplied with air at a slight positive pressure so that dust and fumes cannot enter—a valuable time-saver when pyrometers, hardness testers and other instruments are to be kept at optimum accuracy and dependability.

Instrumentation of Vertical Furnaces

Typical of the special equipment employed is that for airplane nacelles. These are hardened in vertical furnaces, set well up in the air and directly above the quench tanks. The furnaces are muffle units, gas fired and supplied with specially prepared atmosphere to prevent oxidation or other change of the plane parts. Nacelles are quenched through doors in the furnace bottoms.

These furnaces have three firing zones, each with its Micromax Controller. In the round picture above, one group of three Controllers can be seen directly below the clock; the top and bottom instruments, on the first and third zones, are Indicating Controllers, while the middle zone has the Recording Controller which the foreman is examining.

These instruments bring micro-responsiveness to temperature regulation, so that almost simultaneously with the appearance of heat lags or surges, the fuel valves are adjusted to bring temperature back to the control point. Equipments incorporate the outstanding features of Micromax design: sturdy machine-type parts; extra-heavy gears, shafts and bearings; fine construction throughout.

Further information will be sent on request; either a general catalog or specific engineering data, as you prefer.

depends on me!
A Slogan For Every American

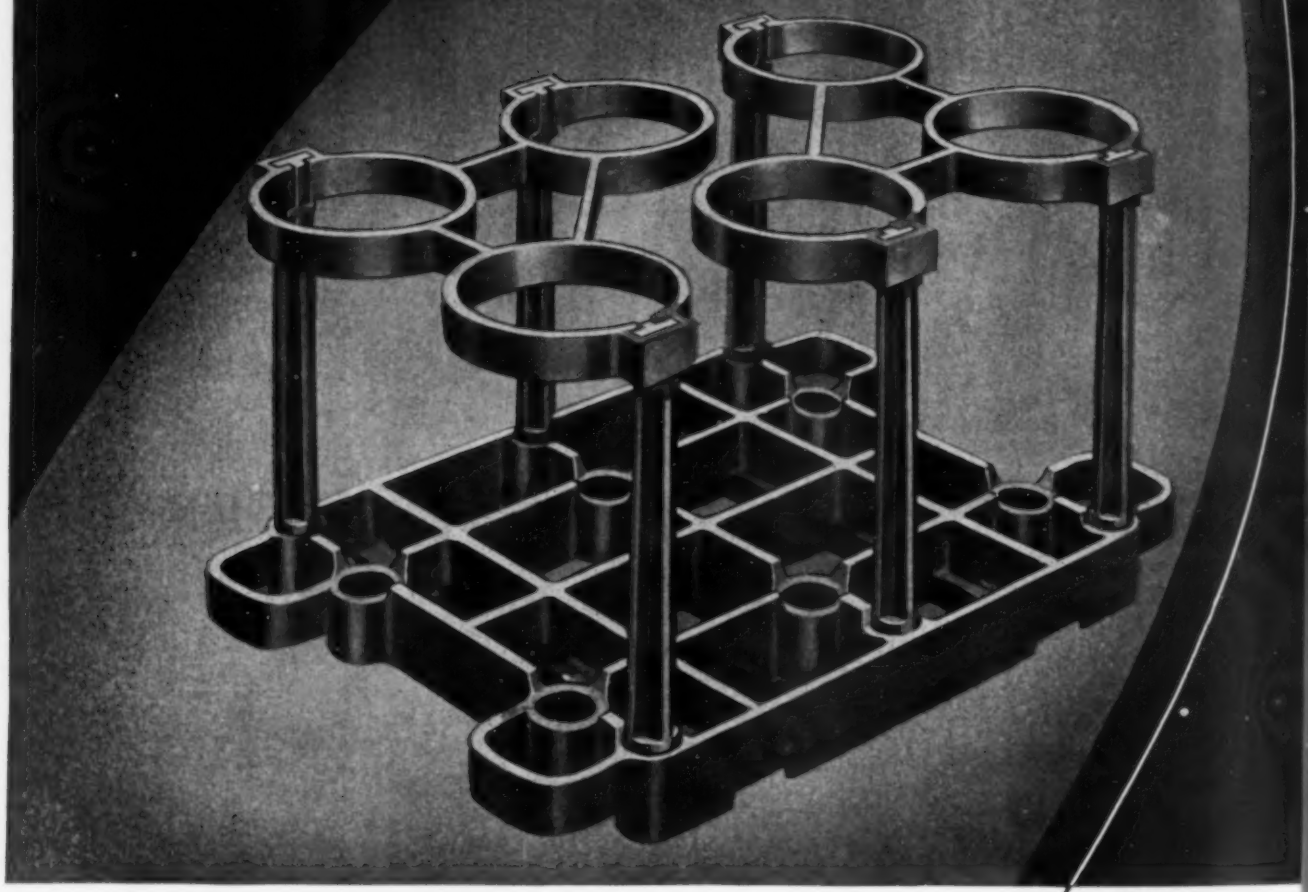
Ref Ad N-33-620(9)

LEEDS & NORTHRUP COMPANY, 4927 STENTON AVE., PHILA., PA.

LEEDS & NORTHRUP

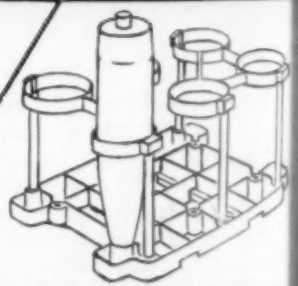
MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Heat-Treat Fixture for 155 mm. Shells



This fixture, designed by Holcroft, is made for them of Hoskins Alloy-502. The 155 mm. shells are loaded onto it, as sketched at the right. The fixture is light, but strong. These features can nearly always be had in any heat-treat tool made of Alloy-502. It is strong at furnace temperature, and is long lived. The alloy is of the 35-15 type and is available, cast or rolled, in your designs, or our own. If you need a good heat resistant metal, write us.

HOSKINS MANUFACTURING COMPANY, DETROIT 8, MICHIGAN

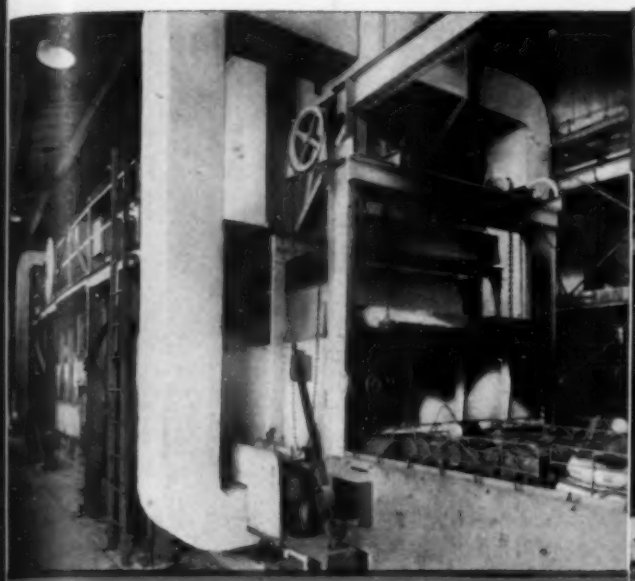


The fixture handles six 155 mm. shells, that float in the positioning rings, and are seated on the nose end, which is open.

HOSKINS PRODUCTS

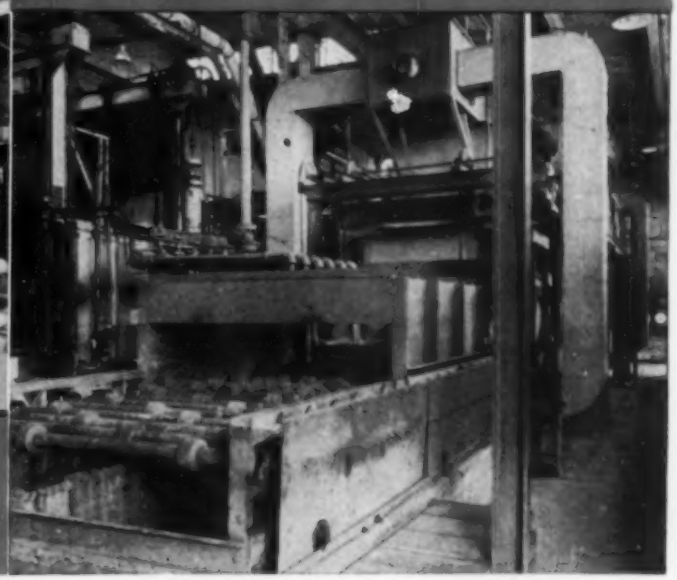
ELECTRIC HEAT TREATING FURNACES • • HEATING ELEMENT ALLOYS • • THERMOCOUPLE AND LEAD WIRE • • PYROMETERS • • WELDING WIRE • • HEAT RESISTANT CASTINGS • • ENAMELING FIXTURES • • SPARK PLUG ELECTRODE WIRE • • SPECIAL ALLOYS OF NICKEL • • PROTECTION TUBES

HEATING ELEMENT WIRE — Chromel — NICKEL-CHROMIUM



DISCHARGE END—Spray quench located outside furnace discharge door to cool annealed material for unloading from roller table.

CHARGING END—Material in baskets on table ready to be charged into furnace for annealing cycle.



DREVER CONTINUOUS RECIRCULATING FURNACE for ANNEALING BRASS CARTRIDGE CASES

Another Drever continuous recirculating furnace . . . taking its place in an established production line where the flow of material ranges up to 10,000 lbs. per hour.

Units of this general type, with variable speed drive and large capacity gas or oil-fired air heaters, provide rapid heating for temperatures of 1250° or below, and are versatile, in that material can be conveyed through the furnace directly on the rolls or in special containers. All control and safety devices are incorporated.

We would be pleased to discuss with you the inherent advantages of Drever Continuous Furnaces which are designed in any required size to meet individual needs.

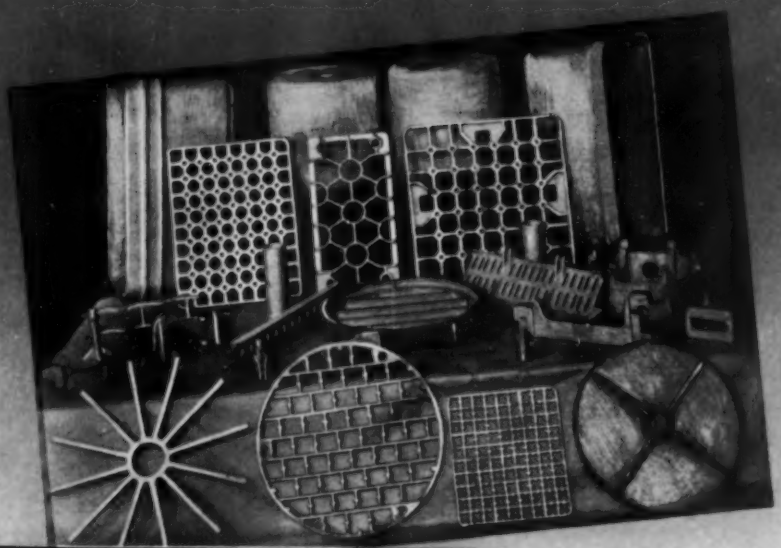
THE DREVER CO.

790 E. VENANGO ST., PHILA. 34, PENNA.

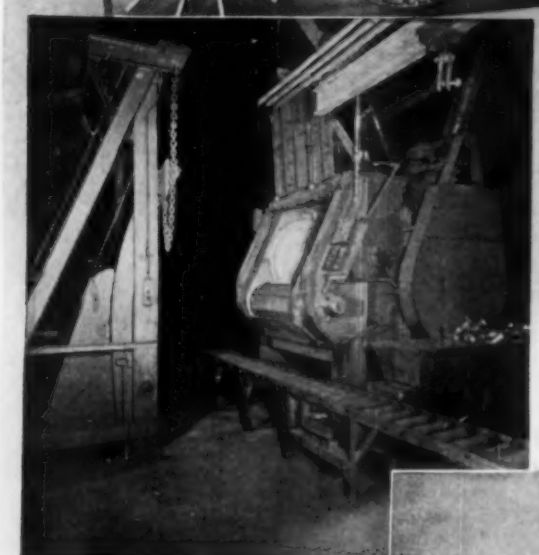
PRESSURE QUENCHES · CONTINUOUS FURNACE LINES · HEAT TREATING FURNACES

There's No Substitute For Alloy Experience —

"SWESCO" ALLOY CASTINGS



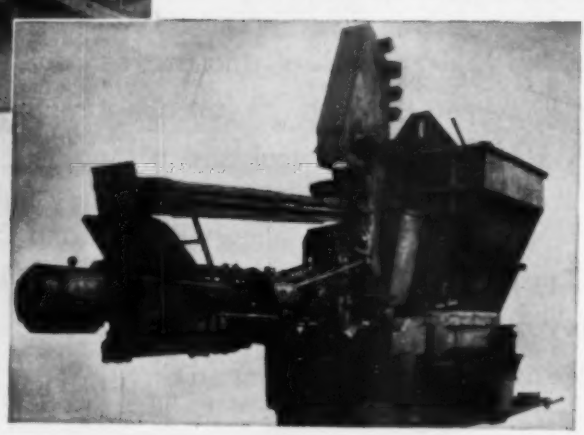
. . . In Greater Demand Than Ever Before . . . For 32 Years "Know-How" Go Into Their Making!



As early as 1912, the Swedish Crucible Steel Company was prominent in the development of nickel-chrome heat resistant castings, designed to resist oxidation, corrosion, and abrasion. Today this early experience is treasured, for the knowledge and skill so gained has proved invaluable in producing "SWESCO" Alloy Castings of superior quality. Evidence of this is their ever-increasing demand by manufacturers who recognize "SWESCO" superiority.

MODERN FACILITIES, SKILL AND CARE . . . MEAN SAVINGS ON YOUR ALLOY CASTINGS REQUIREMENTS.

Pioneers in the development of Alloy Castings to meet today's Industrial demands

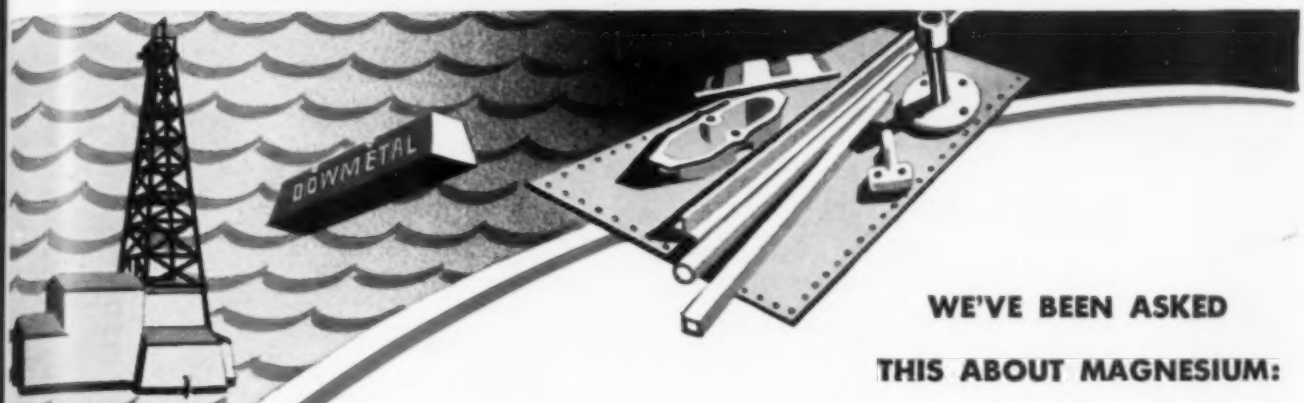


The Sand Slinger and Wheelabrator illustrated are but two of the modern foundry essentials that make Swedish one of the best equipped foundries in the country for the production of Alloy Castings. Our skill, care, modern equipment and, above all, experience can be of real service to you on your Alloy Castings requirements, and we welcome the opportunity to assist you in any way possible. For detailed information please write, wire or telephone Dept. SCS-54.

Swedish CRUCIBLE STEEL COMPANY

Serving Industry For More Than Thirty-Two Years

8561 BUTLER AVENUE . . . DETROIT 11, MICHIGAN



WE'VE BEEN ASKED

THIS ABOUT MAGNESIUM:

How complete are Dow services for the magnesium user?

Dow is the pioneer and major producer of magnesium . . . the principal developer of its alloys and fabrication techniques . . . and the leading sponsor of its widespread application in many fields of industry. So it is only logical to consult Dow relative to any phase of the usage of the lightest of all structural metals.

- Forgings
- Dowmetal Magnesium Alloy Ingots
- Extrusions: Bars, Rods, Tubing, Special Shapes
- Sand Castings, Permanent Mold Castings, Die Castings
- Construction of Welded and Riveted Subassemblies
- Sheet, Plate and Strip
- Technical Service

The broad range of Dow magnesium activities *begins* with the extraction in large quantity of the virgin metal from Michigan brine and from the waters of the sea . . . it *includes* production of a complete line of Dowmetal Magnesium Alloy ingots and an accompanying line of fluxes and protective agents . . . it *extends* to complete mill and foundry facilities for cast and wrought products and a jobbing fabrication shop for stamping, drawn parts and assemblies . . . all *supplemented* with the knowledge accumulated in 28 years of experience in engineering and metallurgical research.

Thus Dow's pre-eminent position in the magnesium field makes it exceptionally well qualified to work with you in any development where the high strength-weight ratio of a metal is valuable.

DOWMETAL *magnesium*

THE METAL OF MOTION

DOWMETAL

MAGNESIUM DIVISION • THE DOW CHEMICAL COMPANY
MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Washington • Cleveland • Detroit • Chicago • St. Louis • Houston • San Francisco • Los Angeles • Seattle

DIVERSITY, CAPACITY, EXPERIENCE IMPORTANT IN GRINDING ORES AND MINERALS

The grinding of ores and minerals is an old and necessary step in their preparation for subsequent processing. New importance has been attached to it because of the discovery that in many instances the size of particles alone has a bearing on the properties of ores and minerals.

In any grinding problem the three essential factors are the diversity, capacity and experience of the mill.

We are equipped with many types of mills . . . rolls for producing granulations, Fuller mills capable of producing fine grindings, mills equipped with air classifiers for producing extra fine grindings, pebble mills for producing coarse to fine grindings, hammer mills and rod mills for producing coarse grindings.

With our diversity of mills we are in a position to handle the custom grinding of from ton lots to many carload lots. We are also able to produce specially sized materials so that the particle dimension can be held within very close limits. We can grind a wide variety of ores and minerals and alloys to the very close tolerances so essential in the chemical processing fields.

In addition, we are equipped with several driers, a large capacity calcining kiln, a tabling unit to beneficiate ores.

We are also equipped with magnetic separators, one of which is believed to be the largest and best constructed magnetic separator in this country.

We urge you to take advantage of our own processed ores and minerals or to use our facilities for custom-grinding any of the following products:

METALS AND FERRO ALLOYS

Ferro Chrome
Ferro Manganese
Ferro Silicon
Ferro Uranium
Ferro Tungsten
Selenium
Ferro Columbium
Ferro Molybdenum
Ferro Titanium
Ferro Vanadium
Iron
Silicon
Tellurium

MINERALS AND ORES

Alunite
Beryl
Fluorspar
Limestone
Magnetite
Pyrite
Sillimanite
Wolframite
Asbestos
Celestite
Hematite
Ilmenite
Manganese Ore
Rutile
Stibnite
Wyomingite
Zirkite
Barytes
Chromite
Kaolin
Magnesite
Monazite Sand
Scheelite
Witherite
Zircon

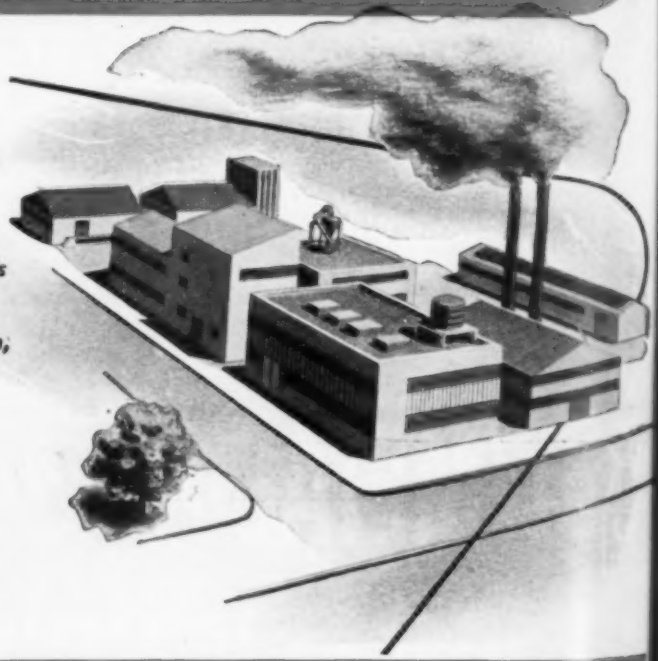
MISCELLANEOUS

Abrasives
Carborundum
Foundry Facings
Pigments
Carbon Electrodes
Coke
Non-toxic Chemicals
Polishing Powders

Twenty-five years of experience in processing many materials, locating sources of materials, selecting the right type of mills or equipment to produce the product wanted at an acceptable price—plus laboratory control of all production—are all behind the Foote custom-grinding service.

"HOUSE OF TOMORROW"

From our "house of tomorrow"—that is, the various Foote plants and laboratories, pour products used by hundreds of industries, and by our Armed Forces and those of our Allies on far flung battle fronts. Ores and minerals, chemicals and alloys, wrested from the earth, and new processes developed in our laboratories and plants, await your consideration, cooperation or application. Let Foote research and products help you today—for tomorrow.



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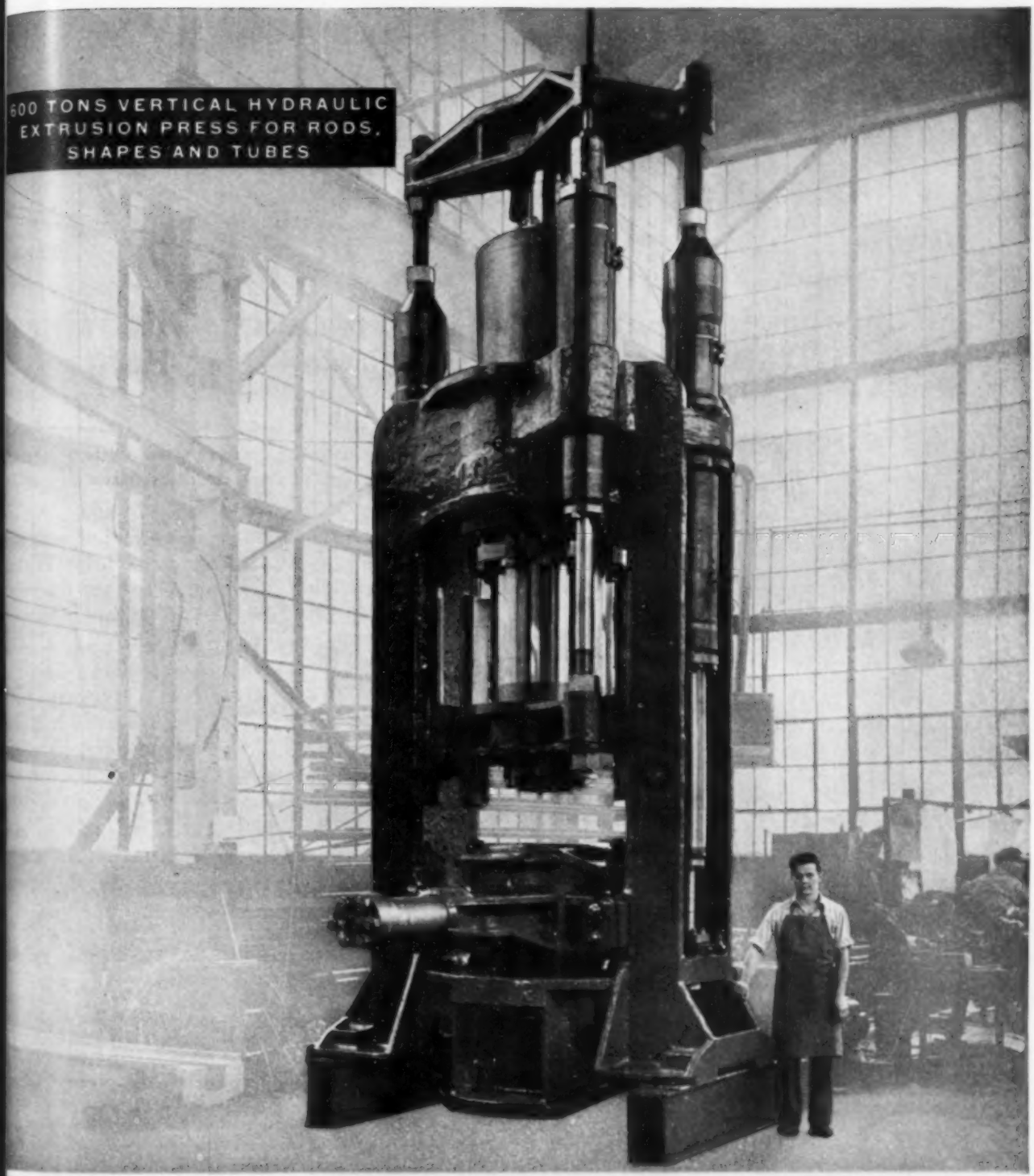

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MISCO *Fabricated* Alloy Products

HEAT AND CORROSION RESISTANT

for Carburizing • Annealing • Hardening • Nitriding and Cyaniding in Air Furnaces and Salt Baths

Misco fabricated trays for nitriding. Operating temperature 930°F. Permits maximum load per unit space and uniform flow of gases.

TO USERS of heat treating equipment Misco offers comple facilities for the fabrication of containers, fixtures and misc laneous alloy products.

Made from rolled material or used in combination with all castings, the construction of Misco Fabricated Alloy Produc can be varied to suit operating conditions, whether the duty normal or extremely severe.

With Misco sheet, castin bars, wire, bolts, nuts a rivets at our disposal—and reliable welding technique, are able to make up fabrica heat treating equipment, lar or small, with equal facili

We will be pleased to quo from your own details or offer suggestions on redesi problems.

Other **MISCO** *Heat Treati*

EQUIPMENT

Furnace Parts . Roller Rails . C veyors . Roller Hearths . Conve Rolls . Trays . Retorts . Therm couple Protection Tubes . Chai Walking Beam Conveyors . C burizing and Annealing Boxes . D ping Baskets . Cyanide and L Pots . Centrifugal Castings and M cellaneous Castings for use at hi temperature or under corrosive c ditions.

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Invest all you ca in U. S. WAR BOND

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Heat and Corrosion Resistant Alloys

Michigan Steel Casting Company

One of the World's Pioneer Producers of Heat and Corrosion Resistant Alloy Castin

1999 GUOIN STREET, DETROIT 7, MICHIGAN

REJECTS REDUCED TO .001!

CARBURIZING TIME CUT IN HALF!

Houghton's Perliton means more gears, better gears for Cleveland Tractor!

By changing over from the former method of gas carburizing to modern liquid carburizing in Perliton salt, Cleveland Tractor has made these outstanding improvements in its gears:

1. Carburizing time reduced from 8 to 4 hours.
2. Scrap rejects reduced from as high as 10% by the gas method to less than 0.1% by salt bath method.
3. Distortion measured in ten-thousandths of an inch.
4. Gears now direct-quenched... plug quenching is no longer necessary.
5. Savings paid for the new furnaces.
6. Much closer control of depth of case.
7. Liquid carburized gears "give much better service with less spalling."

That's a fine record for Houghton's Perliton, the carburizing salt that produces a true carbon case.

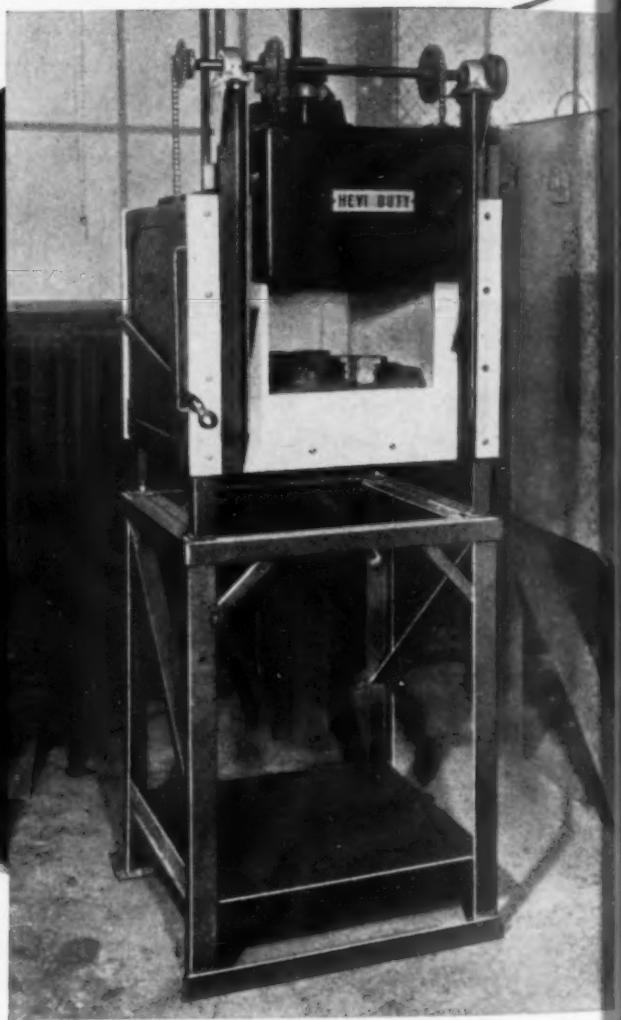
If you want the whole story, write us for a reprint of the descriptive article by W. A. Silliman, Metallurgist, Cleveland Tractor Co. You'll find it highly informative and helpful in planning your own heat treatment for the reconversion days to come. E. F. HOUGHTON & CO., 303 W. Lehigh Avenue, Philadelphia 33, Pa.

Houghton's

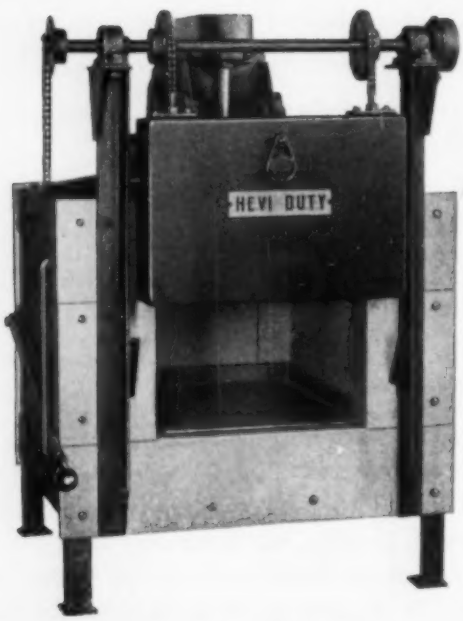
PERLITON LIQUID CARBURIZER

A NEW HEVI DUTY CONVECTION TEMPERING FURNACE

● The Ahlberg Bearing Company, of Chicago use this new Hevi Duty Convection Furnace for the tempering of miscellaneous tools and some high speed and carbon steels with temperatures ranging from 350° F to 1300° F. Unique furnace construction assures uniformity of temperature thruout the heating chamber. Bulletin HD-744 details the advantages of this new addition to the Hevi Duty line — send for your copy.



An MU-12148-A Convection Tempering Furnace at the Ahlberg Bearing Co., Chicago.



MU-12148-A Convection Tempering Furnace. Maximum Temperature 1300° F.

HEVI DUTY ELECTRIC COMPANY

HEAT TREATING FURNACES HEVI DUTY ELECTRIC EXCLUSIVELY

MILWAUKEE, WISCONSIN

If this is what you want in a

CASTING SEALANT...

high sealing efficiency

clean surface after application

resistance to gasoline, other solvents

easy handling in plant or foundry

excellent stability under operating conditions

...HERE'S NEWS

you've been waiting to hear!

MONSANTO Plastics research laboratories have developed a group of highly effective new casting sealants which can be applied with the same equipment and virtually the same methods as with tung oil.

High Sealing Efficiency

The new Monsanto sealants, compounded from a viscous, thermosetting base resin and styrene monomer, have a high sealing efficiency for four basic reasons.

1. They have low viscosity to ensure thorough penetration of the finest pores.
2. They contain no solvents to form vapor or air voids.
3. They are polymerized rapidly by a low temperature bake.
4. They form a rubbery, nonporous solid with excellent adhesion to metal when polymerized or cured in the pores.

Good Chemical Resistance

Because the new Monsanto sealants are thermosetting (i.e. once cured, they will not soften again when exposed to heat) they have good thermal stability. When cured, they are insoluble in aromatic high octane gasoline, lubricating oil, ethylene glycol, isopropyl alcohol and water.

Types Available

Two types of the new Monsanto sealants have been developed and thoroughly proved in foundry tests:

X-117 for magnesium castings
X-118 for both magnesium and aluminum.

A third type is now being tested:
X-119 for iron castings.

Leave Clean Surface

All three types can be applied by vacuum pressure impregnation or by positive pressure with few changes in the standard tung oil processing technique.

After impregnation the uncured resin is easily cleaned from the surface of the casting because its low viscosity permits complete drainage and any remaining surface resin dissolves readily in kerosene dip. Its rapid gel time and freedom from solvents minimizes exudation during cure, leaving clean surfaces.

Easy to Handle

The new Monsanto sealants are supplied as a mixed impregnating solution or as a base resin to be mixed with styrene monomer. Pre-mixed sealants are simple and easier to handle in the foundry and their uniformity is assured by control laboratory tests before shipment.

For full details and technical help in adapting the new Monsanto casting sealants to your operations, write or wire: MONSANTO CHEMICAL COMPANY, Plastics Division, Springfield 2, Massachusetts.

The broad and versatile Family of Monsanto Plastics includes: Lustron polystyrenes • Cerex heat resistant thermoplastics • Vynate vinyl acetals • Nitron cellulose nitrates • Fibestos cellulose acetates • Resinox phenolics • Resimene melamines. Forms in which they are supplied include: Sheets • Rods • Tubes Molding Compounds • Industrial Resins • Coating Compounds • Vuepak rigid, transparent packaging materials.

MONSANTO PLASTICS

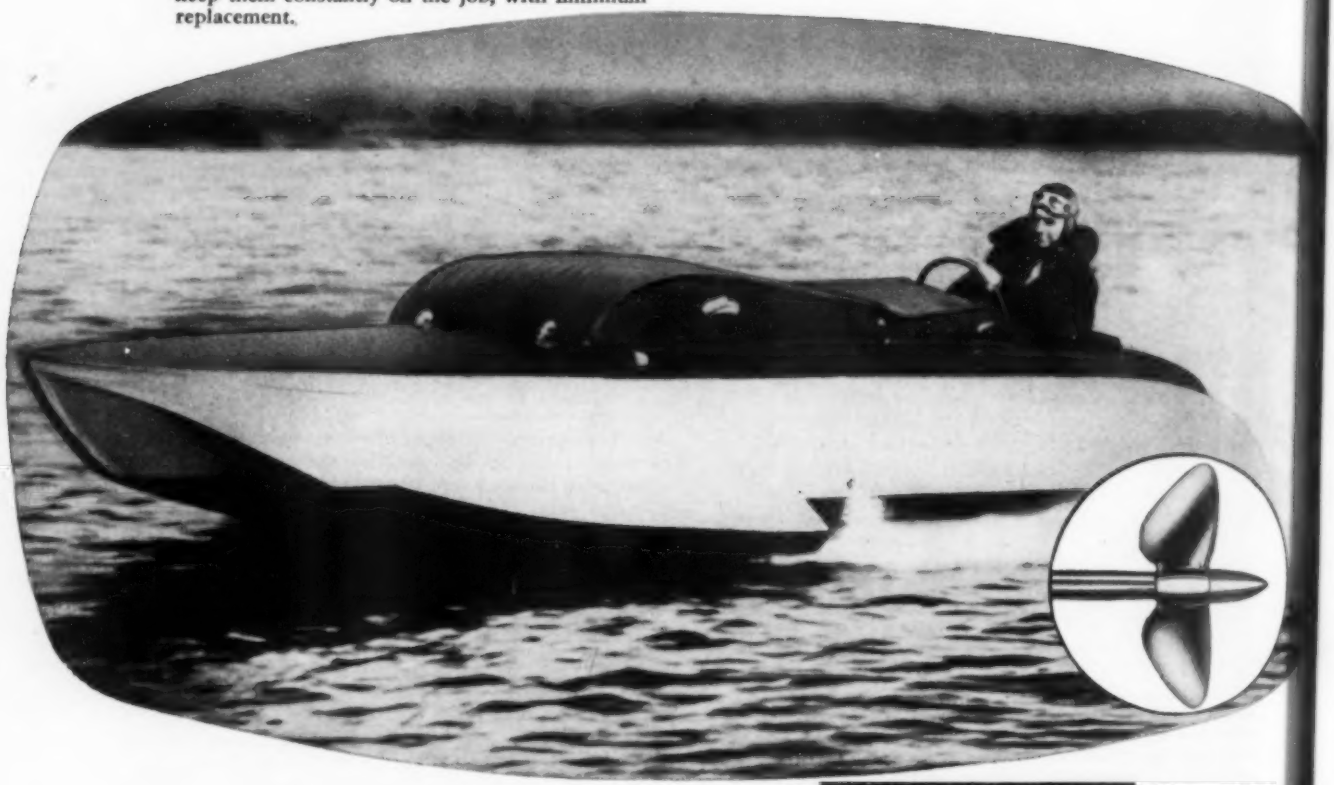
SERVING INDUSTRY... WHICH SERVES MANKIND

You Get

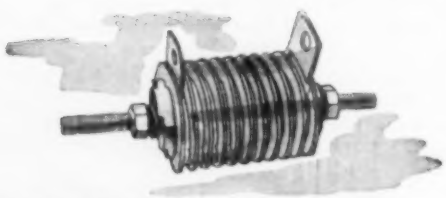
CORROSION RESISTANCE...

HEAT RESISTANCE Carpenter Stainless No. 4-TI or No. 4-CB used in the aircraft exhaust manifolds like that shown above, are typical of a wide range of Stainless grades that meet high temperature service requirements.

WEAR RESISTANCE Stoker worms like this in thousands of homes and industrial plants can be installed and forgotten because Carpenter Stainless Steels Nos. 4 & 6 provide the wear and corrosion resistant qualities necessary to keep them constantly on the job, with minimum replacement.



HIGH STRENGTH/WEIGHT RATIO This speedboat propeller shaft, made from Carpenter No. 8 Free-Machining Stainless transmits maximum horsepower through a minimum diameter. The shaft must remain absolutely straight, even when subjected to sudden power and torque thrusts. And this Stainless provides ample protection against salt water corrosion. If you are looking for similar advantages in your postwar products, investigate easy-working Carpenter Stainless Steels now!



ELECTRICAL RESISTANCE The uniform electrical resistance and easy-forming properties of Carpenter Stainless No. 1-JR are essential in this edge-wound resistor coil used in cargo ships.

Plus these

SPECIAL PHYSICALS

with Carpenter Stainless!

Have you considered the many advantages that can be obtained for your new or redesigned products through the special physical properties provided by Carpenter Stainless Steels? On these pages we attempt to show you some of the many physicals that are available to you in various Carpenter Stainless grades. Right here may be the answer to giving your postwar products greater utility, broader sales appeal.

Carpenter, as pioneer in the development of soft and ductile Stainless Strip and inventor of Free-Machining Stainless bar stock—has always made a specialty of producing Stainless Steels to do specific jobs. Our experienced representatives can help you select the Carpenter Stainless grades whose physical properties most fully meet your requirements. Careful laboratory control and exacting inspection assure consistent uniformity, lot after lot, in the Stainless you receive.

This service means that when your designer specifies Carpenter Stainless he can secure the special physicals he desires, as well as easiest fabricating qualities. This all adds up to faster production, fewer rejects, and lower unit costs for your postwar products.

Give Your Products These Advantages

- Sales Appeal
- Everlasting Beauty
- Freedom from Rust
- No Plating to Peel
- Weight Saving
- Strength and Rigidity
- Ease of Assembly
- Fewer Service Complaints

Call in your nearby Carpenter representative now and take full advantage of his diversified Stainless experience in helping to get the best results with Stainless. But do it today, for planning time is getting short.

THE CARPENTER STEEL COMPANY, 133 W. BERN ST., READING, PA.

Carpenter STAINLESS STEELS

BRANCHES AT Chicago, Cleveland, Detroit, Hartford, St. Louis, Indianapolis, New York, Philadelphia

...BOTH require BORON

ENGINES, arms, projectiles, armor—almost all military equipment is now made of alloy steels, and the use of alloying materials has been greatly economized without sacrifice of quality by the addition of Boron.

Implements of peace also—machinery, tools, containers, structural parts—are and will be in growing measure made strong and durable by improvement of the steels and irons that go into them; and again the improvement will be economically brought about by aid of such hardening agents as Boron. Available supplies are adequate. The percentages that give best results are almost incredibly small. The Molybdenum Corporation has developed a ferro-boron that dissolves easily in molten metal and yields a high recovery.

Inquiries concerning any use of Molybdenum, Tungsten, or Boron will be welcomed.

AMERICAN Production, American Distribution, American Control—Completely Integrated.
Offices: Pittsburgh, New York, Chicago, Detroit, Los Angeles, San Francisco, Seattle.
Sales Representatives: Edgar L. Fink, Detroit; H. C. Donaldson & Co., Los Angeles, San Francisco, Seattle.
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MOLYBDENUM CORPORATION OF AMERICA
GRANT BUILDING PITTSBURGH, PA.

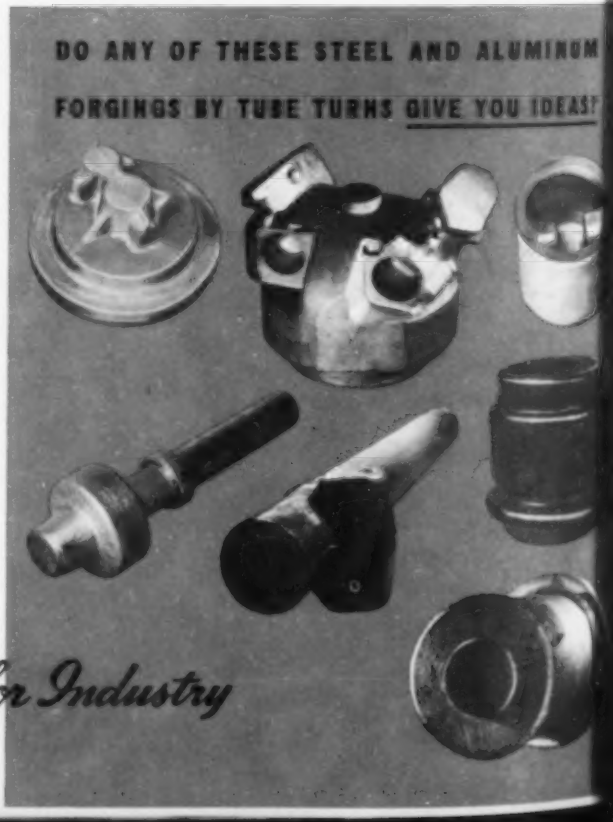
NO. 13 OF A SERIES. HIGHLIGHTS OF WORLD WAR II. PRESENTED BY TUBE TURNS (INC.) LOUISVILLE, KY. SEE OTHER SIDE

"I'M GETTING TUBE TURNS' OPINION ON ITS FORGE-ABILITY"

Perhaps *you* have a part or product that forging would improve . . . or a present forging job that could be bettered in precision, cost or service.

We welcome opportunities to tackle difficult upset or press forgings, in either steel or light metals. At Tube Turns you'll find a stimulating kind of cooperation — in which practical forging skill and engineering knowledge are accented by resourceful thinking and original techniques. You'll find laboratories that offer virtually every modern method for mechanical, chemical and electrical research and testing. You'll find ample production facilities for volume output plus exacting accuracy — upsetters and presses in sizes up to the largest, heat treating furnaces of the most recent types and one of the largest die shops in the country.

That's why you often hear it said, "I'm getting Tube Turns' opinion" . . . and its sequel, "We're giving Tube Turns the job."—TUBE TURNS (Inc.), Louisville 1, Ky.



TUBE TURNS *Forgings for Industry*

A NEW Application for Wilson RECTANGULAR BELL TYPE FURNACES! *for* MALLEABLEIZING IRON CASTINGS

WILSON

Gas Fired Low Cost Heating Uses ANY type of Industrial Gas

HERE is the first picture of an installation of 19 Wilson Rectangular Bell Type Furnaces and 25 Bases for malleableizing heavy section iron castings. This same type of furnace is also in use for the same process in medium and light weight sections, with the pieces contained in alloy baskets.

25 Furnaces now in operation — full information available on request.

This furnace is gas tight and is heated with Wilson vertical radiant tubes. A protective atmosphere is generated from the carbon in the metal without additional equipment.

The Wilson Annealing Unit is covered by Patents Nos. 1,952,402, 2,068,477, 2,078,356, 2,081,612, 2,089,843, and other patents pending.

ENGINEERED AND CONSTRUCTED BY THE

Lee Wilson ENGINEERING Co., Inc.

20005 West Lake Road CLEVELAND, OHIO

Telephone ACademy 4670

INDUSTRIAL FURNACES ★ RADIANT TUBE HEATING ★ HEAT TREATING PROCESSES

12 REASONS WHY YOU

Do You Want Faster, Cleaner, More Uniform Heating?

CHECK THESE FEATURES

✓	**1. INSTANT AVAILABILITY**	With Westinghouse Radio Frequency Generators, power is turned on or off by pressing a button—no waiting for the furnace to heat up or cool off.
✓	**2. COMPLETE CONTROLLABILITY**	Power is increased or decreased *with the speed of electrons* by turning a knob—apparatus especially adaptable to automatic control devices.
✓	**3. RAPIDITY**	Heat is generated within the material itself—no "soaking" time required. Automatic operation further speeds production.
✓	**4. FLEXIBILITY**	Heat generating apparatus often can be brought right beside the work. Heat is confined to the work area desired—ideal for changing production schedules.
✓	**5. REPRODUCTIVITY**	Heat after heat can be repeated automatically without interruption—or can be duplicated at any time in the future, with absolute accuracy.
✓	**6. UNIFORMITY**	All desired parts of the material are heated simultaneously—not by conduction from one area to another—thus minimizing radiation losses.
✓	**7. CLEANLINESS**	When you use radio frequency heating you get no residue, negligible scale, no products of combustion and no open flames.
✓	**8. COMPACTNESS**	No fuel to store—no bulky pipes and valves. The Westinghouse Radio Frequency Generator is self-contained—and in many cases, portable.
✓	**9. ECONOMY**	Power consumption is limited to that required for the operation. Otherwise, the unit draws only enough to light the tube filaments and operate the auxiliaries.
✓	**10. LOW MAINTENANCE**	There are a minimum of moving parts to wear out. Tube life is guaranteed. Lengthy shut-downs for repair are eliminated.
✓	**11. SIMPLICITY**	Once the Westinghouse heating unit is adjusted to a process, operation merely requires pushing buttons and setting dials to calibration data.
✓	**12. SAFETY**	Adequate safeguards are provided to protect operator and apparatus from dangerous electrical forces.

Westinghouse RADIO FREQUENCY HEATING

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

USAVE WITH WESTINGHOUSE
RADIO FREQUENCY HEATING

- ***For Dielectric Heating of Nonconducting Materials***
- ***For Induction Heating of Ferrous and Nonferrous Metals***

Speed — cleanliness — uniformity — these are the characteristics of Westinghouse Radio Frequency Heating. By this electronic method, jobs are reduced from hours to minutes. Heat is created within the material itself—instantly—uniformly—and under precise control. There's no waiting for heat to "soak" in; no rejects due to heat-damaged surfaces.

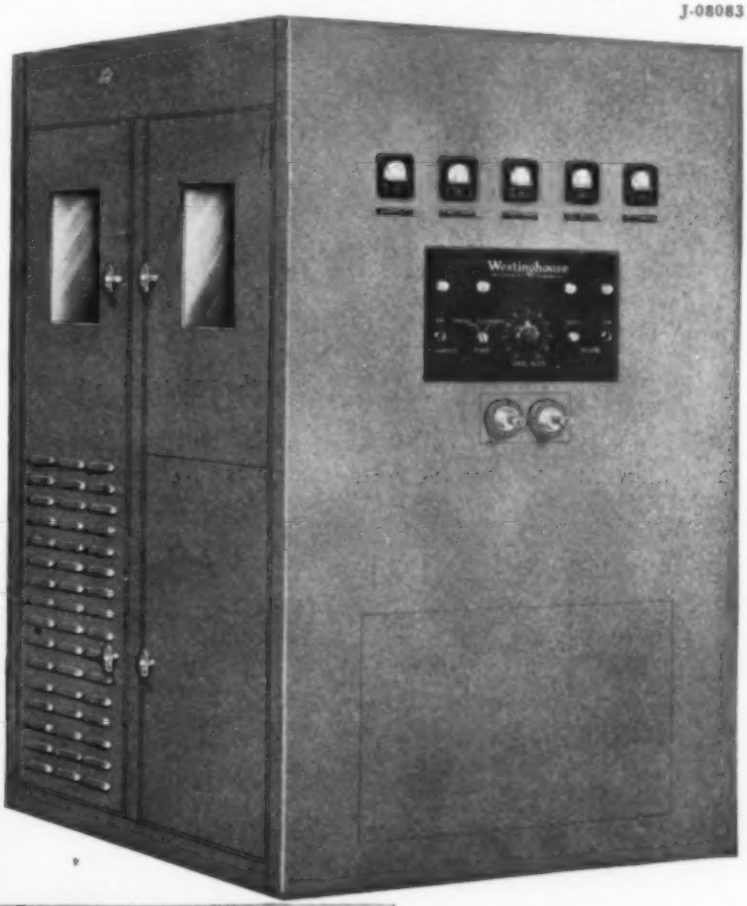
Applications include metals, wood, chemicals, plastics, paper, rubber, textiles and foodstuffs.

Westinghouse single unit design "packages" all the radio frequency generating and control equipment into a safe, compact sturdy metal cabinet. These generators are built in 1, 2, 5, 10, 20, 50, 100 and 200 kw sizes—at a range of frequencies wide enough to meet all probable dielectric and induction heating needs. For more information ask for Descriptive Data 85-800; for aid on your specific problem call your nearest Westinghouse representative. Westinghouse Electric & Mfg. Co., Box 868, Pittsburgh 30, Pa.

J-08083

20 KW RADIO FREQUENCY GENERATOR. This unit is designed for permanent installation to handle a wide range of induction and dielectric heating applications. Controls and meters are conveniently located on the front panel. Dead-front construction safeguards operating personnel.

2 KW RADIO FREQUENCY GENERATOR. This mobile unit is ideal for small work—it requires a minimum of floor space. The "table top" work surface eliminates the need for special worktables; all controls are conveniently located on the protected sloping panel.



Electronics at Work

Trigger Fingers . . .

Fighting for their country, millions of men from every walk of life are learning the value of good mechanisms . . . and the springs that help to make them work. Their trained hands will be quick to judge the worth of the products of the future. Their influence will affect mechanical developments in many fields. For those men who will improve, invent, pioneer the products of a country again at peace, the Wallace Barnes Company offers the resources of an organization trained to design and produce good springs in their infinite variety.

CONSERVE METAL — DESIGN WISELY

1918 — THEN AND NOW

ARMY NAVY

Barnes-made Springs

ENGINEERED PEP AND POWER

WALLACE BARNES COMPANY DIVISION OF ASSOCIATED SPRING CORPORATION BRISTOL, CONNECTICUT, U.S.A.

TOMORROW'S ENGINE?

BOHN

MECHANIZED warfare has had a tremendous effect on the development of internal combustion engines. The lessons now being learned will appear in concrete form in the motor car engines in the after-the-war era. One thing that is definitely sure is that new engine designs will furnish greatly increased horsepower per pound of engine weight. Engines will be smaller and by the greater use of aluminum alloys, will be considerably lighter. Bohn—one of the pioneers of light alloy parts for automobile engines—will be in the forefront in aiding these new developments.

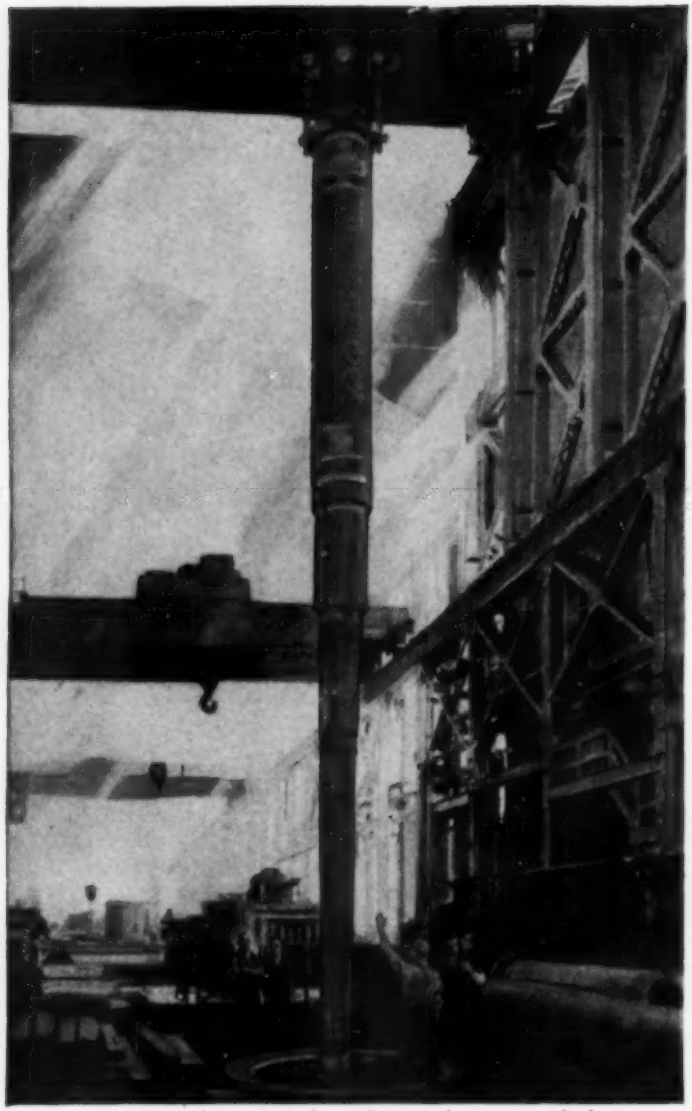
BUY WAR BONDS

BOHN ALUMINUM AND BRASS CORPORATION • DETROIT 26, MICH.

GENERAL OFFICES—LAFAYETTE BUILDING

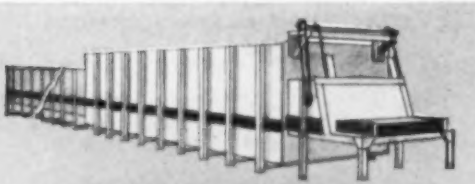
Designers and Fabricators—ALUMINUM • MAGNESIUM • BRASS • AIRCRAFT-TYPE BEARINGS

HOW TO HEAT-TREAT LONG OR CIRCULAR PARTS WITH MINIMUM WARPAGE



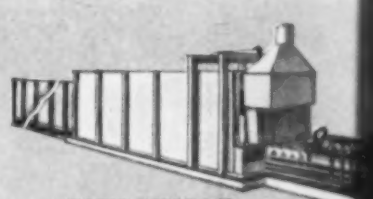
- - - these huge gun barrels, can be suspended vertically from a top supporting fixture. They are not subjected to distortion as when piled one on top of another in a horizontal furnace. When quenching is required, a hoist lifts the parts, then lowers them into a vertical quench tank. Circular parts, such as - -

- - - large gears and sprockets which cannot be suspended or supported on end, are placed into a convenient holding fixture. The cylindrical heating chamber assures uniform heating around the periphery of the part. In addition to guarding against warpage, a G-E pit furnace offers other advantages: - - -

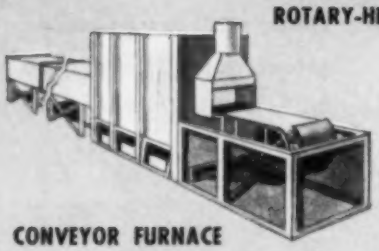


ROLLER-HEARTH FURNACE

ROTARY-HEARTH FURNACE



PUSHER FURNACE



CONVEYOR FURNACE

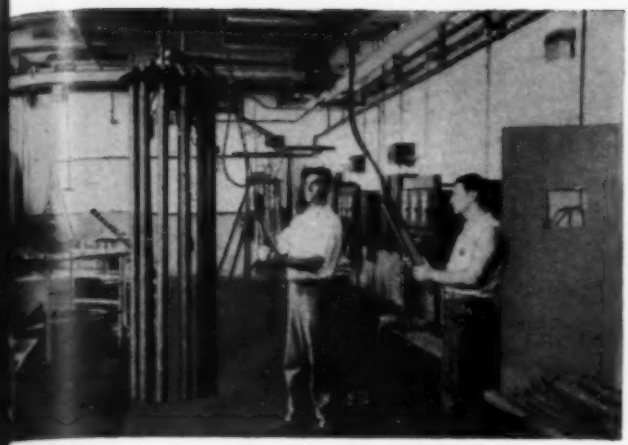
BOX FURNACE

PIT FURNACE

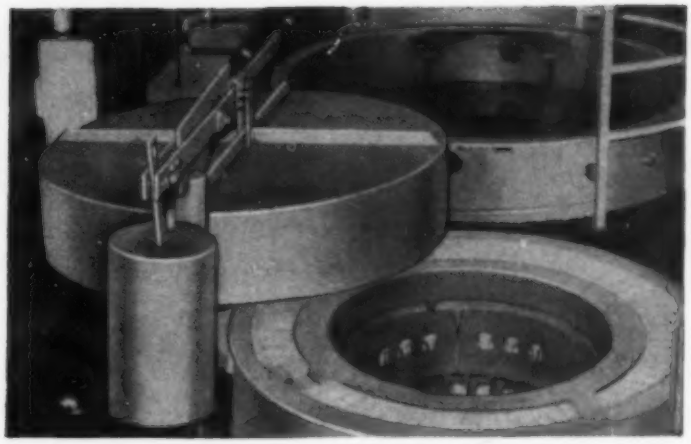
GE ELECTRIC FURNACES

FOR PRACTICALLY EVERY INDUSTRIAL NE

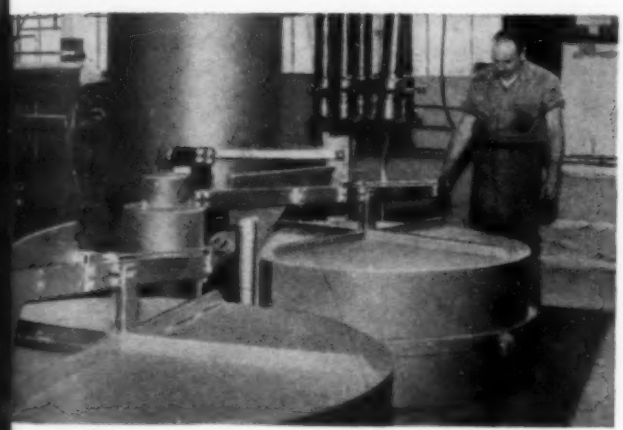
BACKED BY A NATIONWIDE ENGINEERING SERVICE



To heat long parts, such as tubes and shafts, or circular parts, such as gears and sprockets, with the minimum of warpage, two factors must be considered: the parts must be heated and quenched *uniformly*, and they must be so *positioned* as to minimize distortion. That means they must be heated in - - -



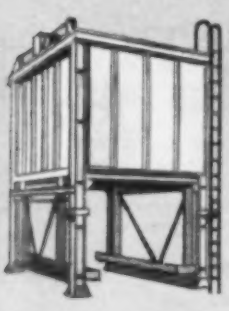
- - - a furnace that is specially designed for that type of work—an electric pit furnace. The heating elements in G-E pit furnaces are mounted all around the inside of the circular wall. Heat distribution is uniform; therefore, distortion caused by uneven heating is prevented. Long parts, such as - - -



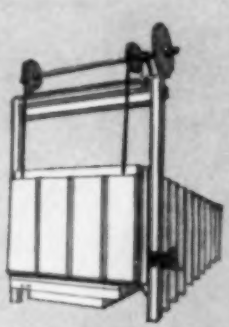
- - - charging and discharging are simplified by a counter-weighted swing-type cover and, when desired, by a built-in hoist. Fan-forced circulation can be provided for dense loading, and protective atmosphere can be used to prevent decarburization and scaling. For more information, get in touch with - - -

R. W. STEENROD
G-E Heating Specialist
Los Angeles

- - - one of our many industrial-heating specialists, who are located in principal cities all over the country. He will be glad to study your requirements and to suggest the most efficient means of meeting them. His recommendations are based on years of practical experience. For details - - -



ELEVATOR FURNACE



CAR-BOTTOM FURNACE

Buy all the BONDS you can—*and keep all you buy*

GENERAL ELECTRIC

- - - contact the nearest G-E office, or mail the coupon below:

GENERAL ELECTRIC COMPANY, SEC. 675-102
Schenectady 5, N. Y.

—Please send me your bulletin, GEA-4070, which describes your vertical pit furnaces.

—Please send me your bulletin which describe the following other types or furnaces:.....

.....

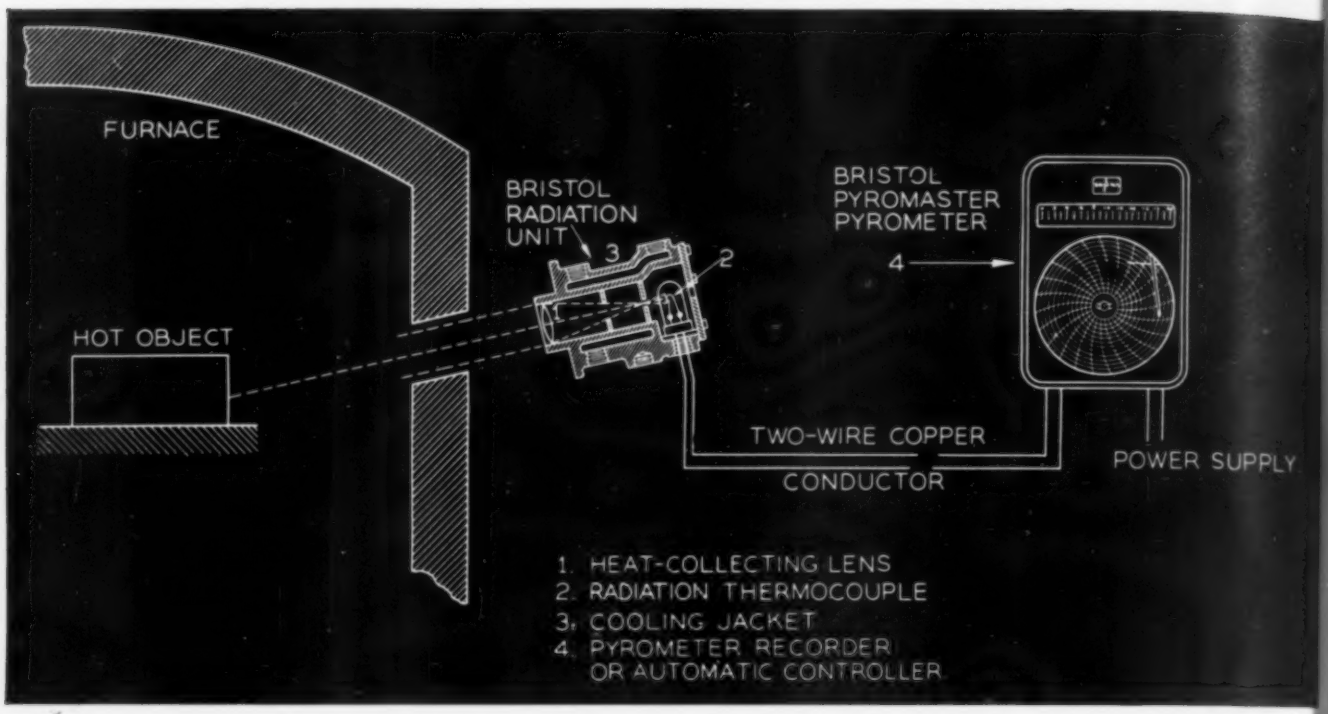
—Please have a specialist call at the earliest opportunity.

Name.....

Company.....

Address.....

City.....State.....



HOW TO TELL THE TEMPERATURE OF A HOT STOVE WITHOUT SITTING ON IT

On Jobs where a Thermocouple is Impracticable, Bristol's PYROMASTER Radiation Pyrometer Gives Perfect Accuracy...

Where it's too hot for a thermocouple (over approx. 2800° F)... where there are space or other limitations... and for taking *surface* temperatures or temperatures of the "work" itself in a furnace—Bristol's PYROMASTER Radiation Pyrometer gives you accurate readings *from outside the hot zone.*

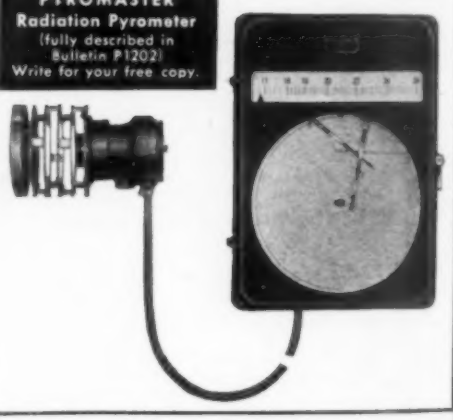
The temperature-sensitive element is mounted outside the furnace. Its lens picks up heat rays emitted by the hot object and focuses them on a thermocouple which in turn registers them on a Pyrometer.

Readings are accurate because (1) the "sighting" element watches the temperature of the object itself, not the surrounding atmosphere; (2) the radiation unit is calibrated to within an accuracy well within that of commercial thermocouples; (3) the thermocouple used has so little mass that there is practically no time lag.

The complete unit rarely needs attention after once being properly sighted. Being out of the heat zone, there are no maintenance problems due to deterioration.

Models: recording, indicating, controlling (electric-type or air-operated).

PYROMASTER
Radiation Pyrometer
(fully described in Bulletin P1202)
Write for your free copy.



APPLICATIONS

1. Furnaces
   a. continuous heat-treat
   b. controlled-atmosphere
   c. glass
   d. porcelain enameling
2. Kilns
   a. ceramic
   b. rotary
3. Extrusion presses

... Gives YOU the Most from Heat

AUTOMATIC CONTROLLING AND RECORDING INSTRUMENTS

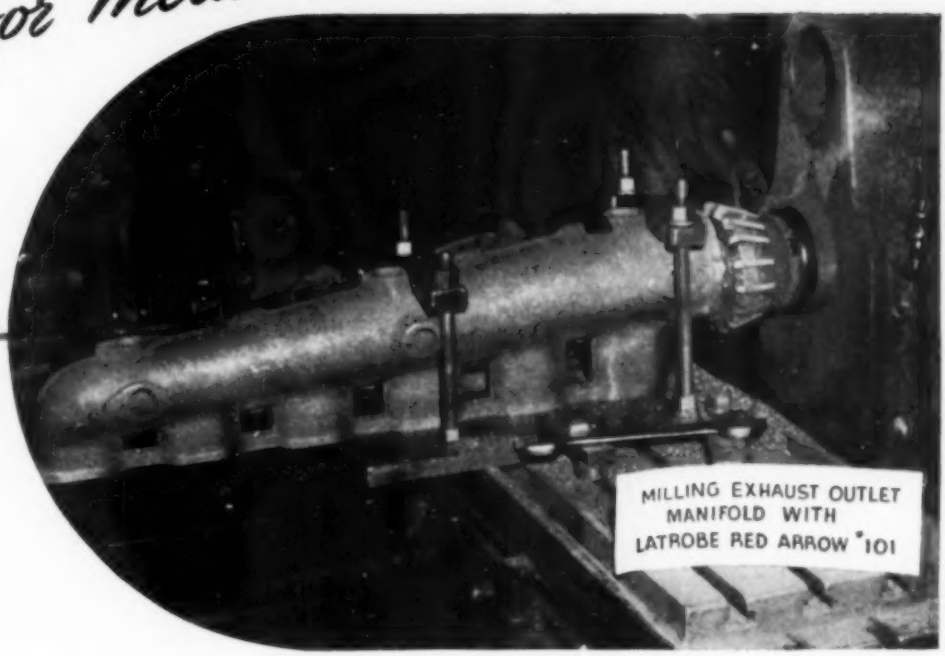
The Bristol Co. of Canada, Ltd.
Toronto, Ontario

THE BRISTOL COMPANY, 103 Bristol Road
WATERBURY 91, CONN.

Bristol's Instrument Co., Ltd.
London, N. W. 10, England

Have you tried LATROBE RED ARROW

—the Superior Cast Alloy for Metal Cutting Tools



Requires **no heat treatment**

Easily brazed to tool body

Ground with ordinary wheels

LATROBE RED ARROW Cast Alloy Cutting Tools operate most efficiently in that "intermediate cutting range" between high speed steel and tungsten carbide. Cutting tools cast from these alloys make important savings possible—***more pieces per grind, higher speeds and feeds, better surface finish!***

Standard sizes of Tool Bits carried in warehouse stocks.

MANUFACTURERS OF SMALL TOOLS

Latrobe Red Arrow is available in the "as cast" state for grinding to the dimensions of the finished tool.

Latrobe ELECTRIC STEEL COMPANY

MAIN OFFICES and PLANT · LATROBE · PENNSYLVANIA

Deepfreeze Cascade −120° F. Industrial Chilling Machine designed for numerous high production cold treating operations.

GAUGE GROWTH ELIMINATED

AFTER *Cold Treating* IN A

Deepfreeze

Industrial Chilling Machine

"H" type pin gauges completely stabilized by cold treating.

In Addition, Gauge Life Lengthened as a Result of Increased Metal Hardness

Here is a typical example of how manufacturers are using cold treating to stabilize gauges and other precision machine parts. Under conventional production methods the "H" type pin gauges shown above grew as much as .001" to .0015" while stored in tool cribs. Now, after cold treating, at −120° F. in a Deepfreeze Industrial Chilling Machine before final machining, the gauges hold their original dimensions for indefinite periods of time. In addition, the increased hardness of the metal obtained in the same cold treatment resulted in improved wearing quality of the gauges.

COLD TREATING FACTS

MACHINE—Deepfreeze — 120° F. Industrial Chilling Machine.

PART—"H" type pin gauges.

GAUGE SIZES—3.000 4.330, 5.000, 6.250, 7.000.

MATERIAL—S.A.E. 1095 Carbon Tool Steel for gauging blocks; cross piece from cold rolled bars.

TREATING PROCEDURE—(1) Heat to 1450° F.; (2) water quenched; (3) immersed in water approximately 210° F. for 1 ½ hours; (4) return to room temperature; (5) transfer to Deepfreeze at — 120° F. for 1 ½ hours; (6) return to room temperature; (7) given a draw of 375° F. for 1 ½ hours; (8) cooled to room temperature; (9) return to Deepfreeze for 1 ½ hours; (10) return to room temperature; (11) immersed in hot water at 210° F. for 1 ½ hours; (12) return to room temperature; (13) again cold treated in Deepfreeze at — 120° F. for 1 ½ hours; (14) return to room temperature; (15) finished ground to size.

NOTE: Every effort was made to make the rise and fall of the temperature continuous without any prolonged rest between the hot and cold point reached.

RESULTS: These gauges were checked for size immediately after cold treatment, then four months later, and once again two months later. It was found that growth was held to a maximum of .00004" as compared to the previous growth of .0015."

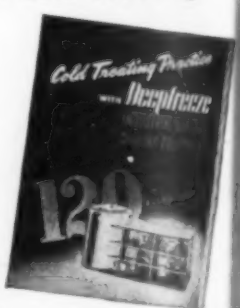
How Others Are Using Cold Treating

Cold treating is being practically applied at present by numerous manufacturers of diversified products for the following purposes:

Treating of high-speed steel cutting tools.
Shrinking of metal.
Shrink-fit assembly.
Stabilization of gauges.
Hardening precision machine parts.
Testing of aircraft instruments and materials.
Testing of lubricants, paints, plastics, chemicals, synthetic rubber and pharmaceuticals.

FREE *Complete, Up-to-date Cold Treating Information...*

Our new 40-page booklet covers every phase of cold treating from its inception to the present time. It gives specific information on how such manufacturers as Curtiss-Wright Corporation, Cincinnati Milling Machine Company, Ford Motor Company, Savage Tool Company, Kearney & Trecker Corporation, and many other Deepfreeze users are applying cold treating to their production. Write today for Bulletin No. 1-4.



Only Motor Products can make a "DEEPFREEZE"

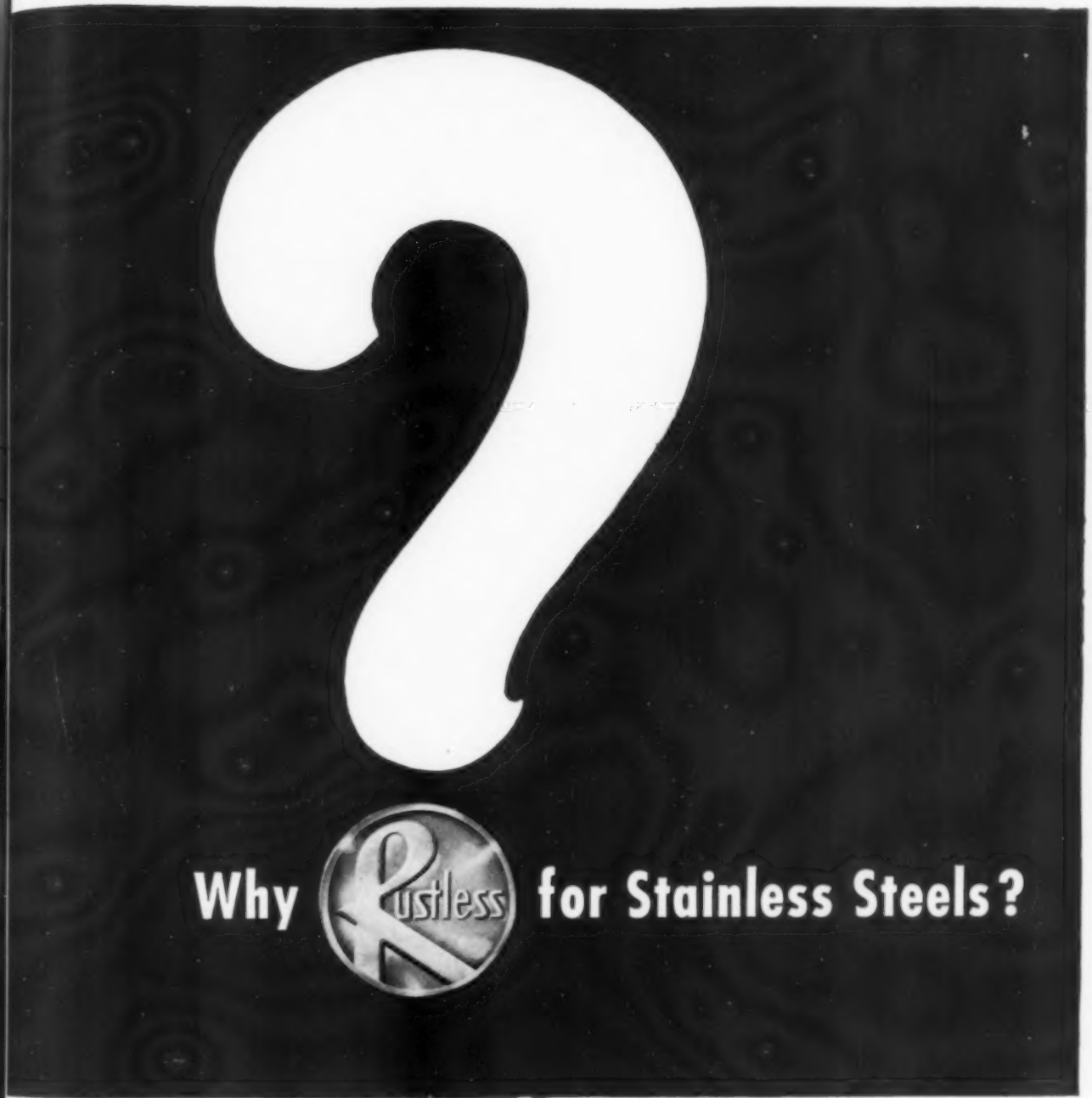
Deepfreeze

2325 DAVIS STREET
NORTH CHICAGO, ILLINOIS

TRADE MARK DEEPFREEZE REGISTERED UNITED STATES PATENT OFFICE

Industrial Chilling Equipment for Shrinking, Testing, Hardening and Stabilizing Metals

Division of Motor Products Corporation, Detroit, Mich



RUSTLESS has become one of the most important factors in the stainless steel industry.

One reason for this is that we specialize in the making of stainless steel, and experience has proved to American industry that it pays to deal with a specialist.

Our specialization has enabled us to work successfully with fabricators in solving manufacturing problems that involve machining, forging, cold working, welding, soldering, riveting, heat treating—or in selecting the proper type of stainless in order to obtain ease of fabrication and the economy of long, sometimes limitless life.

Your order, once you place it with us, is not just processed with standard alloy steel mill equipment. We employ many added engineering features that bring stainless steel into uniformly useful form.

Rustless makes stainless steels in over twenty grades readily available, and not only delivers billets, bars and wire, but provides detailed technical assistance with their fabrication. If you want to know more about stainless — ask Rustless.

RUSTLESS

IRON AND STEEL CORPORATION

BALTIMORE 13, MARYLAND

Producing STAINLESS STEELS *Exclusively*

SALES OFFICES: BALTIMORE
BUFFALO • CHICAGO
CINCINNATI • CLEVELAND
DETROIT • LOS ANGELES
MILWAUKEE • NEW YORK
PHILADELPHIA • PITTSBURGH
ST. LOUIS • DISTRIBUTORS
IN PRINCIPAL CITIES

"Without fear of contradiction we state that this instrument, with its continuous balance principle, marks the greatest advance in industrial instrumentation since World War 1"

A NEW PRINCIPLE IN INSTRUMENTATION

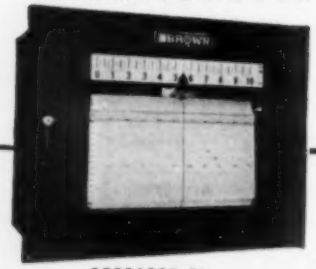
Introduced in 1941 as a flight recorder for testing army and navy aircraft, and since limited largely to direct war projects, the Brown *ElectroniK* Potentiometer is now available in increasing quantity to general industry. Without fear of contradiction we state that this instrument is the greatest advance in the art of industrial instrumentation since days of World War I.

Used with conventional wiring and thermocouple installations, the Brown *ElectroniK* Potentiometer is rapidly outmoding all other forms of temperature controllers in the petroleum and other process industries.

Thousands of operation hours have proved its superior performance . . . accuracy . . . sensitivity . . . ruggedness. Its Electronic "Continuous Balance" Operating Principle means precise control every second, with uniformity hitherto impossible.

If the manufacture of your product involves temperature measurement or control—we invite your inquiry. A Brown engineer will give you a prompt opinion as to what Brown "Continuous Balance" can accomplish in your plant. Address The Brown Instrument Company, 4503 Wayne Avenue, Philadelphia 44, Pennsylvania.

BROWN *ElectroniK* POTENTIOMETER



OPERATES ON "CONTINUOUS BALANCE" PRINCIPLE

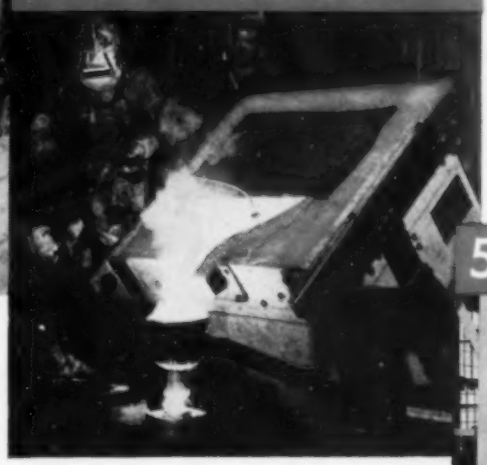
LISTEN . The Blue Jacket Choir with Danny O'Neil every Sunday 11:05 to 11:30 A. M. E. W. T., C. B. S.

INSTRUMENTS BY BROWN CONTROLS BY MINNEAPOLIS Honeywell

4 TONS

Ajax-Northrup furnaces show a high alloy recovery. Uniformity of melt is assured — it stirs as it melts. And there's little chance for contamination.

1 TON



Big furnaces can be used as ladles, or can be poured into crucibles.

A line of medium-sized furnaces provides great flexibility.

500 LBS.

Melting Miracles . . .

WITH AJAX-NORTHRUP HIGH FREQUENCY

he high frequency generator and a 4-ton Ajax-Northrup furnace can elt and pour 11 heats or 44 tons of alloy steel in 24 hours! A small rnace in the laboratory of the same plant can melt 8 ounces of steel alloy 8 minutes. Duplicate analyses are exact, with practically no loss of ements, no contamination and longer lining life.

these days of tailor-made analyses, of quantities ranging from ounces 10 tons and of necessity for speed with accuracy, Ajax-Northrup high equency provides the "melting miracles" that are becoming everyday curances in progressive foundries.

t in Ajax-Northrup furnaces to handle your melting where speed, special oys, quick change-overs, or wide variations in size of melts are required. e will be glad to recommend the best equipment for today's needs, and ll show you how you can plan for tomorrow.

ONE OUNCE

Most of our modern alloys came from Ajax-Northrup laboratory furnaces such as this. Best for precious metals, too.

64

AJAX-NORTHRUP

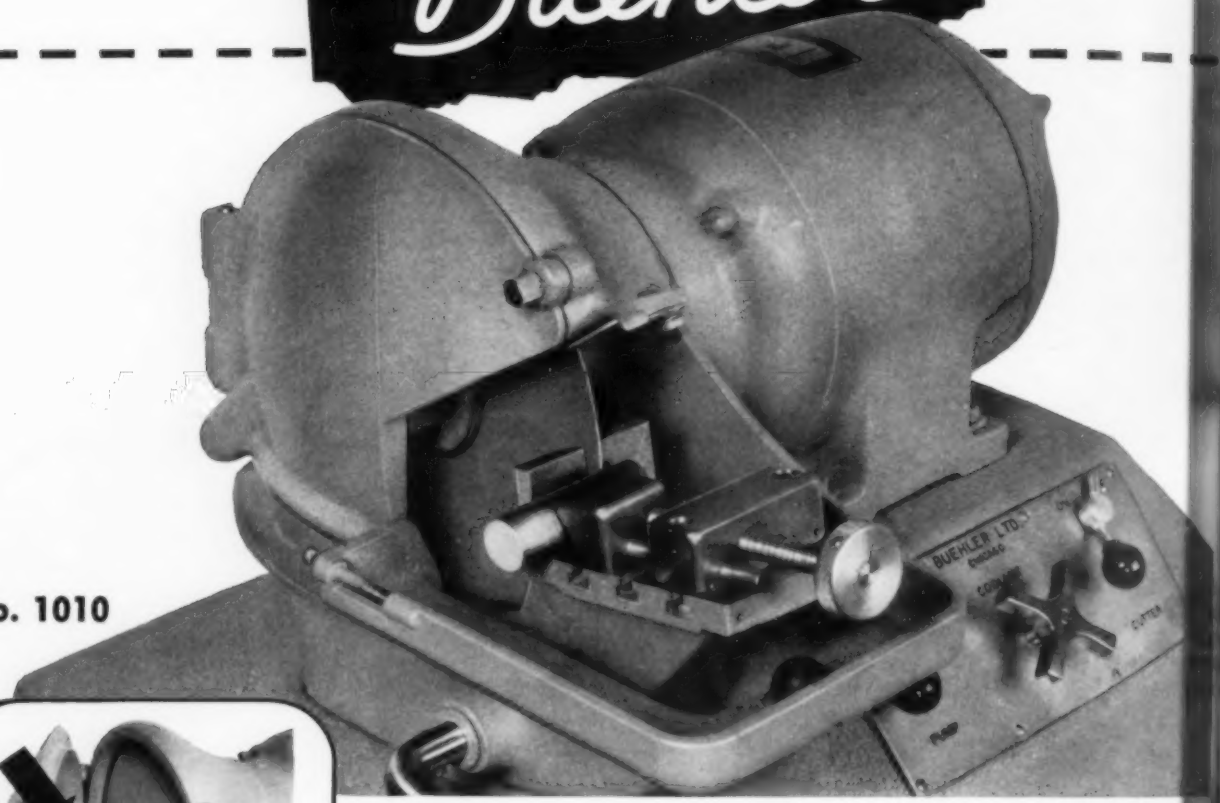
HIGH-FREQUENCY HEATING

AJAX ELECTROTHERMIC CORPORATION • Ajax Park TRENTON 5, N. J.

MELTING

ASSOCIATE COMPANIES . . . THE AJAX METAL COMPANY. Non-Ferrous Ingot Metals.
AJAX ELECTRIC FURNACE CORPORATION. Ajax-Wyatt Induction Furnaces.
AJAX ELECTRIC COMPANY, INC. Ajax-Hultgren Salt Bath Furnaces.
AJAX ENGINEERING CORPORATION. Aluminum Melting Furnaces.

Buehler



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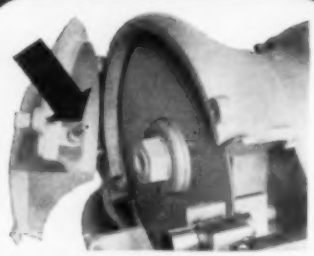


Splash guard opened showing jet pipe for coolant; a companion jet is on the opposite side of the wheel.

Complete view of cabinet showing storage bin for extra wheels and tools.

NEW 1 H. P. Cut-Off Machine

A laboratory size cutter with ample power for fast cutting of samples up to 1" in diameter.

This cut-off machine is built with the usual Buehler emphasis on precision in both the construction of the machine itself and the work it performs. The controls are arranged for the utmost convenience of the operator—a feature that contributes to speed and accuracy in cutting samples.

The cutting wheel mounted directly on the ball bearing motor shaft is free from side play or vibration and is cooled by a stream of coolant directed on both sides of the wheel under the guard.

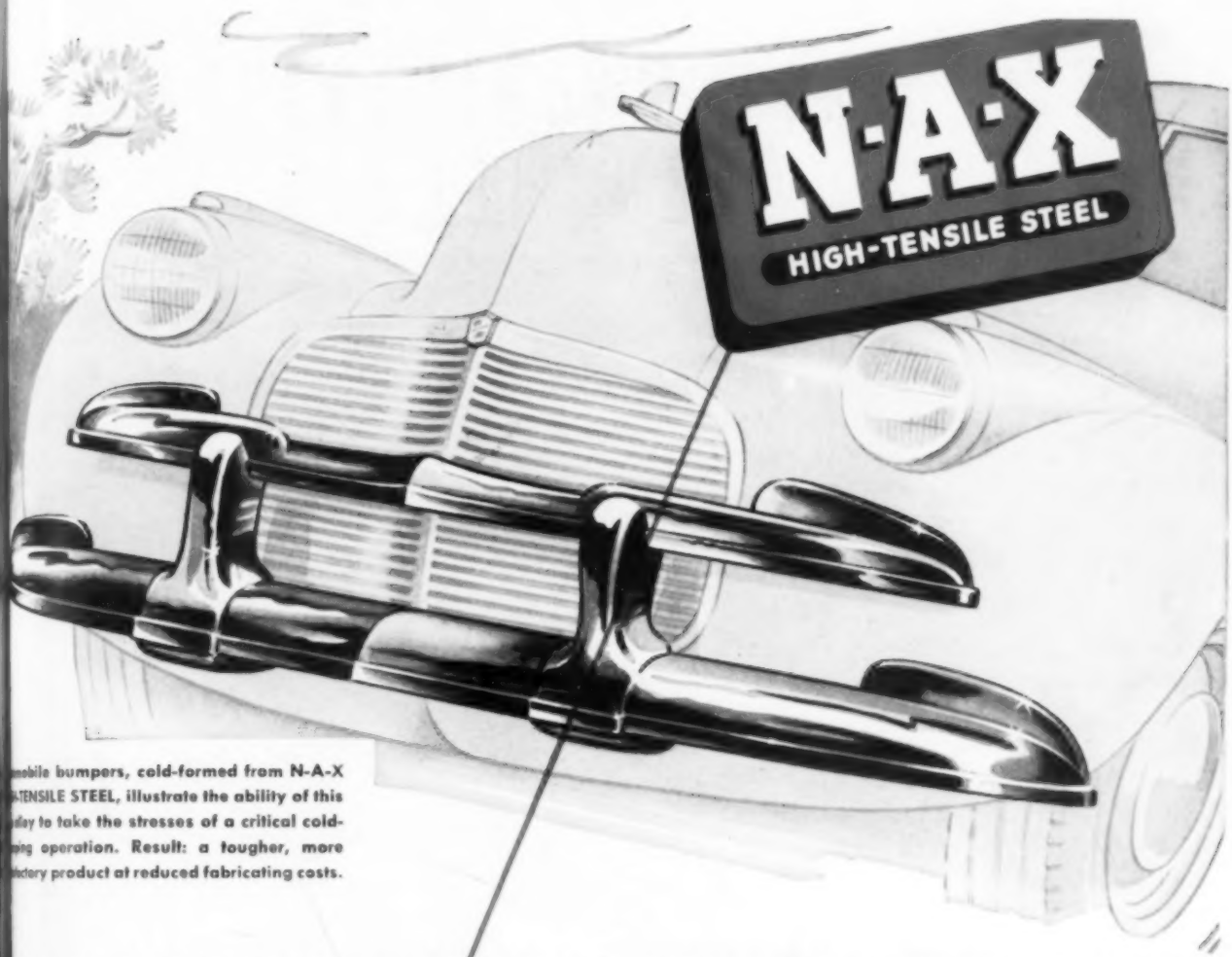
The cutting is done on the front of the wheel by using the long lever handle to raise the clamp base holding the sample to contact the wheel. This mechanism is balanced so that pressure against the cutting wheel is under perfect control at all times by the operator. A metal splash guard, removed in the illustration, furnishes protection from spray.

Overall dimensions are 24" x 28" x 50". Shipping weight, 575 lbs.

THE BUEHLER LINE OF SPECIMEN PREPARATION EQUIPMENT INCLUDES . . .
CUT-OFF MACHINES • SPECIMEN MOUNT PRESSES • POWER GRINDERS
EMERY PAPER GRINDERS • HAND GRINDERS • BELT SURFACERS
POLISHERS • POLISHING CLOTHS • POLISHING ABRASIVES

Buehler Ltd.
A PARTNERSHIP

METALLURGICAL APPARATUS
165 WEST WACKER DRIVE, CHICAGO 1, ILLINOIS



mobile bumpers, cold-formed from N-A-X
-TENSILE STEEL, illustrate the ability of this
day to take the stresses of a critical cold-
ing operation. Result: a tougher, more
tactory product at reduced fabricating costs.

HIS HIGH-TENSILE STEEL "TAKES OVER" WHERE DRAWING STRESSES ARE TOUGH

-X HIGH-TENSILE STEEL has stepped into some
h spots in the production of intricate shapes. It has
d to production men that here is a great steel to
with, from the standpoints of both manufacturing
tions and finished performance.

ut it in a few words, N-A-X HIGH-TENSILE STEEL
what it takes to make a stronger, tougher product
gh more efficient production methods. Its excep-
l ductility and resistance to impact, inherent in the
rain structure of a great alloy, often make possible
peed and economy of cold-forming on pieces which
be worked hot when other grades of steels are used.
where critical drawing stresses require hot work,
-X HIGH-TENSILE STEEL provides the important
ntage of maintaining its high physical properties with
minimum cooling distortion even after it has been subjected to a wide range of temperatures. No subsequent treatment is needed to maintain "as rolled" specifications.

Add to these advantages the high fatigue life and resistance to corrosion and abrasion that qualify N-A-X HIGH-TENSILE STEEL for varied types of applications, and you'll see why this fine-grain, low-alloy steel is a factor in postwar planning. Great Lakes Steel metallurgical service is yours on request: Let's have your problem.

GREAT LAKES STEEL
Corporation

DETROIT 18, MICHIGAN • SALES OFFICES IN PRINCIPAL CITIES
Division of NATIONAL STEEL CORPORATION. Executive Offices, Pittsburgh, Pa.

GREAT STEEL FROM GREAT LAKES

HIGHLIGHTS OF N-A-X ALLOY STEEL

N-A-X HIGH-TENSILE STEEL compares favorably with other low-alloy high-tensile steels in yield and tensile strength, with outstanding ductility and notched bar values. In applications where it replaces mild-carbon steels, it serves to reduce weight or increase strength through the utilization of these properties in design.

Another property that may interest you is the excellent weldability of N-A-X HIGH-TENSILE STEEL—whether welded to itself or to other high-tensile or structural steels of welding quality.

N-A-X 9100 SERIES STEELS are produced in carburizing and constructional grades. Except for carbon, they have a chemical analysis that is constant within definite ranges. Together with X-9100 Series steels, containing molybdenum, they provide hardenability ratings to cover a wide variety of requirements, yet give an all-purpose analysis to yield properties. Molybdenum confers great depth hardenability to extend the usefulness of the N-A-X 9100 Series, which are medium-hardening steels.

N-A-X ARMORPLATE is an example of the exacting requirements that Great Lakes can meet with this low-alloy series. One of the X-9100 Series steels is the basis of the armor we produce for tanks, armored cars and practically all landing craft.

B&L ... FREE-MACHINING OPEN HEARTH

for HEAVY-DUTY SERVICE

TO keep your production costs low and your product quality high . . . use B&L free-cutting Open Hearth Screw Stock, especially when fabricating heavy-duty parts like this husky worm-gear drive shaft.

In machinability, B&L Open Hearth Screw Stock is comparable to the medium-sulphur Bessemer Steels, but it responds to carburizing or simple heat treatment to a safer and better result.

Available in standard grades, as-rolled Cold Finished . . . or furnace-treated for specific applications.

COLD FINISHED STEEL AND SHAFTING

FIGURE YOUR STEEL COMPUTATIONS WITH B&L Production and Estimating CALCULATOR

Write for this handy chart . . . Sent on request.

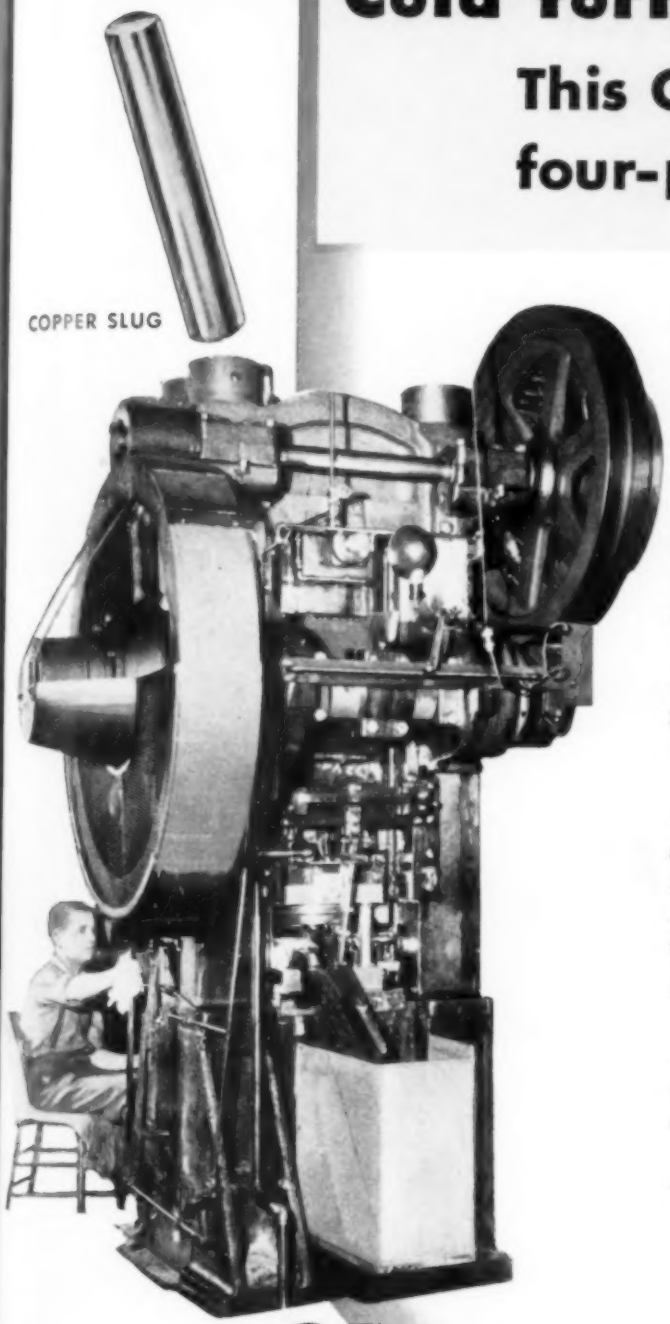
BLISS & LAUGHLIN, INC.

HARVEY, ILL. • BUFFALO, N. Y. MANSFIELD, MASS.

Sales Offices in all Principal Cities

Cold formed in one stroke

This Copper cap replaces four-piece Gillette assembly



Caps for Gillette Razors were formerly made in four pieces; the curved plate with a centered hole, a threaded center pin to which the handle was attached, and two studs for holding the blade in position. Furthermore, assembling the cap was a slow and tedious operation.

But things are different now—a faster, more accurate and economical method has been devised. Because of the excellent cold working properties of copper, thousands of caps are now produced daily . . . formed in one piece . . . in 400-ton presses.

Coils of Anaconda Copper Rod .320" diameter, are cut into slugs 1¾" long and are magazine-fed into the press. The cold formed part, with flash attached, is illustrated below in actual size. The sequence of finishing operations is also shown.

RESULTS: *1.* Production has been speeded up about 200%. *2.* The one-piece construction eliminates the possibility of assembled parts working loose. *3.* Extremely accurate dimensions, necessary for blade alignment, are maintained without difficulty. And, as nothing serves like copper as a rust-free base metal for applied finishes, these Gillette Razor parts are readily plated with gold, nickel, chromium—or as desired.

Copper, or one of its many workable alloys, may be the answer to a similar job which you may consider especially difficult. Your inquiry will be given every consideration by our Technical Department.

THE AMERICAN BRASS COMPANY

General Offices: Waterbury 88, Connecticut
Subsidiary of Anaconda Copper Mining Company
In Canada: ANACONDA AMERICAN BRASS LTD., *New Toronto, Ont.*

ANACONDA
from mine to consumer

Anaconda Copper & Copper Alloys

It takes more than Modern Equipment to meet ALL Sheet Metal Requirements

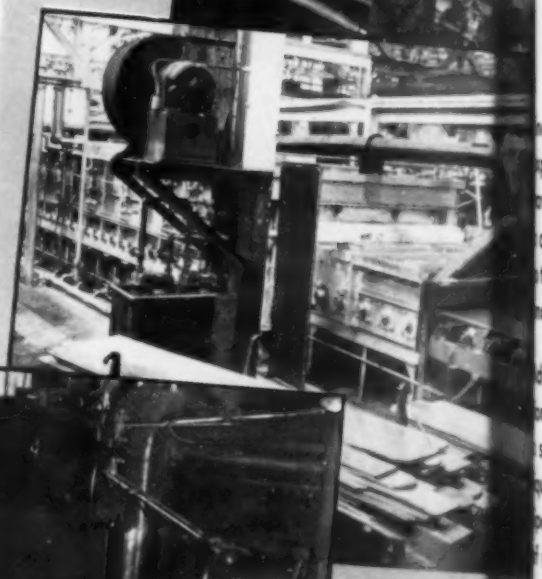
Production men know that low costs and smooth-flowing manufacturing operations go hand in hand when materials are consistently uniform—when sheet after sheet or coil after coil have the same fabricating characteristics.

But there's more to the making of such metal than modern equipment—important as that is. To produce brass plate, sheet or strip that meets ALL requirements calls for strict technical control over every step of production, from the casting shop to the last pass on the finishing rolls. For only in this way can the composition, grain size, temper and finish be controlled to obtain the best combination of properties for spinning, stamping, deep drawing or other fabricating operations.

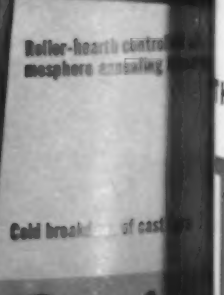
In all probability, much time was devoted to the design and development of your sheet metal products—and also considerable money in tooling up for their production. So when you order copper, brass, bronze, or nickel silver, take the added precaution of specifying "ANACONDA". This is your assurance that the product is made by THE AMERICAN BRASS COMPANY to consistently uniform specifications and tolerances. 44210

Cold rundown rolling of coils

Second operation on four-high roll



Casting bars in water-cooled mold



Roller-hearth control... mosphere annealing

Cold break... of cast...

THE AMERICAN BRASS COMPANY

ANACONDA
from mine to consumer

General Offices: Waterbury 88, Connecticut
Subsidiary of Anaconda Copper Mining Company
In Canada: ANACONDA AMERICAN BRASS LTD., *New Toronto, Ont.*

Anaconda Plate, Sheet and Strip

WHERE KNOWLEDGE IS AIR POWER

owledge of design and air flow and perienced craftsmen, many of whom ve been making Spencer Turbos for quarter of a century, all contribute the outstanding records of perform- ce made by Spencer Turbos.

dvancing from the simple applica- n on an oil or gas fired furnace to score of special applications, from uid agitation to Link Trainers, the encer Turbo-Compressor has scores uses in industry today.

In addition to bulletins on each of the standard types of Spencer Turbos shown above, we offer the Spencer Turbo Data Book which gives tables, formulas, electrical specifications and a description of many varied applications.

Keep your present Spencers well greased for the duration but plan for new post-war applications now.

THE SPENCER TURBINE COMPANY • HARTFORD 6, CONNECTICUT

257-E

TURBO-COMPRESSORS

ROTO-FINISH
SPEEDS PRODUCTION

ON STEEL, BRASS, ALUMINUM, MAGNESIUM, STAINLESS STEEL and NICKEL STEEL PARTS

WHETHER you are still pushing for greater war output—or planning peace-time operations—the Roto-Finish time-and-labor-saving technique is worth serious consideration.

Originally developed as a great production aid to the plating industry, Roto-Finish has found innumerable war-time uses—replacing hand operations in removing burrs and preparing surfaces for plating—maintaining precision tolerances never before possible in mechanical finishing operations.

All of the parts shown above were processed by Roto-Finish. But they only begin to reveal the possibilities of this new finishing method. The best way to discover its possibilities for you, is to send sample parts for processing and complete production data. Write for complete information today.

THE STURGIS PRODUCTS CO.
249 JACOB ST., STURGIS, MICHIGAN

Upsetting gets work under way fast

In two quick steps, this little part is made. The head and the shank with projection are upset from Alcoa Aluminum wire in a rivet header. A blanking operation shapes the head, and the part is ready for heat treating.

Dimensions can be closely controlled in these heading and blanking operations. Parts, like the carriage bolts you see in the photograph, can be produced with well filled-out square shoulders without the need of expensive milling operations.

Where design and quantities warrant production by upsetting, this process develops sizable economies. In addition to being fast, it saves raw material. You use all the metal you start with, obtaining final shapes by upsetting.

Alcoa is equipped to supply you with aluminum parts produced either on rivet headers, on automatic screw machines or a combination of both. Recommendations are based, therefore, on the most economical method. ALUMINUM COMPANY OF AMERICA, 2101 Gulf Bldg., Pittsburgh 19, Pennsylvania.

ALCOA ALUMINUM

Craftsmen

ARE AS GOOD AS THEIR TOOLS . . . .

● Up at the Yale and Towne Manufacturing Company in Stamford, Connecticut, craftsmen have been making the well-known "Yale" locks and builders' hardware for many years. The enviable reputation enjoyed by this company is the result of their insistence for fine quality.

Now as a major contributor to the war effort, Yale and Towne are producing hydraulic pistons and cylinders. Constantly endeavoring to improve their already superior quality, they use the Brush Surface Analyzer in both laboratory and shop. With this instrument they are able to study surface finishes, accurately measured to one millionth of an inch (.000001") from chart recordings instantly made as the specimen surface is explored.

THE BRUSH DEVELOPMENT COMPANY

3373 PERKINS AVENUE • CLEVELAND 14, OHIO

HOGGING?
Fine Finishing?

-do BOTH with this high-speed tool steel

Bethlehem Red Tiger was always a good high-speed cutting steel, but the Improved Red Tiger has even sharper claws and a harder bite. It's more durable, too; when cutting the average alloy steel, it will give more pieces per grind at speeds ranging from 70 to 120 surface feet a minute.

Increased carbon and vanadium content—in proper balance—has given Improved Red Tiger unusual freedom from brittleness and very high resistance to abrasion. This is one of the reasons why the keenness of the cutting edge is maintained over a longer period.

When using Improved Red Tiger, you don't have to have the most modern, most rigid types of machine tools. The new Red Tiger is engineered to withstand shock, vibration, and chatter—and you know what they can do to the more highly specialized type of tool bit!

Improved Red Tiger is primarily supplied in tool bit form or standard sizes of bar stock. It is suitable for the entire cutting range, from hogging to fine finishing cuts; it combines ruggedness with precision. Why not ask a Bethlehem representative for full details?

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Bethlehem Steel Export Corporation, New York City

Analysis of Improved Red Tiger

C	Cr	W	V	Mo
1.00	4.50	18.50	3.00	2.00 max.

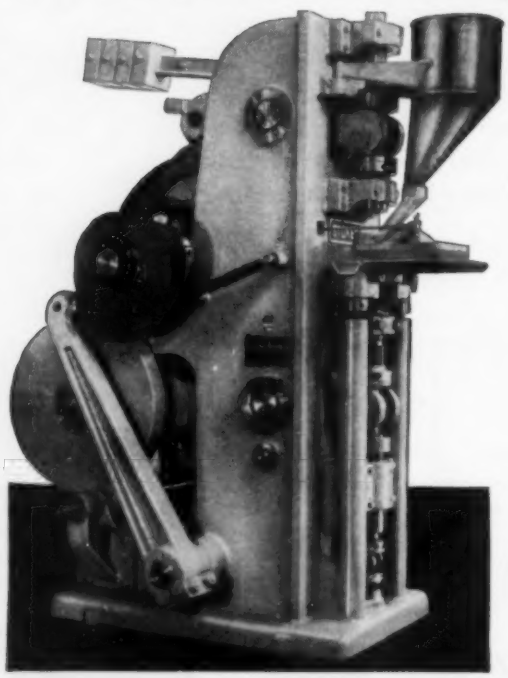
Red Tiger
(Improved) HIGH-SPEED TOOL STEEL

BETHLEHEM STEEL

"THOUSANDS OF MAN-HOURS SAVED"

by ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

POWDER METALLURGY and Stokes Compressing Machines



THESE gun mount parts formerly required hours for machining. Now they are formed on Stokes Automatic Presses by powder metallurgy, in a matter of a few seconds.

The saving of thousands of man-hours per year is matched by comparable money and critical material economies as well.

And in Post-War Industry, these and several new and improved Stokes Tabletting Machines will provide the essential manufacturing shortcuts for cost reduction required in a highly competitive market.

Plan your post-war products to profit from powder metallurgy and save 20% to 80% of the cost of many parts. This has been the experience of many manufacturers. And select *rugged* Stokes Presses — frequently operated at as high as 70% overload without appreciable deflection of the press — an important factor in making accurate parts. Stokes Presses reflect our 25 years of specialized experience in designing and building such equipment for powder metallurgy.

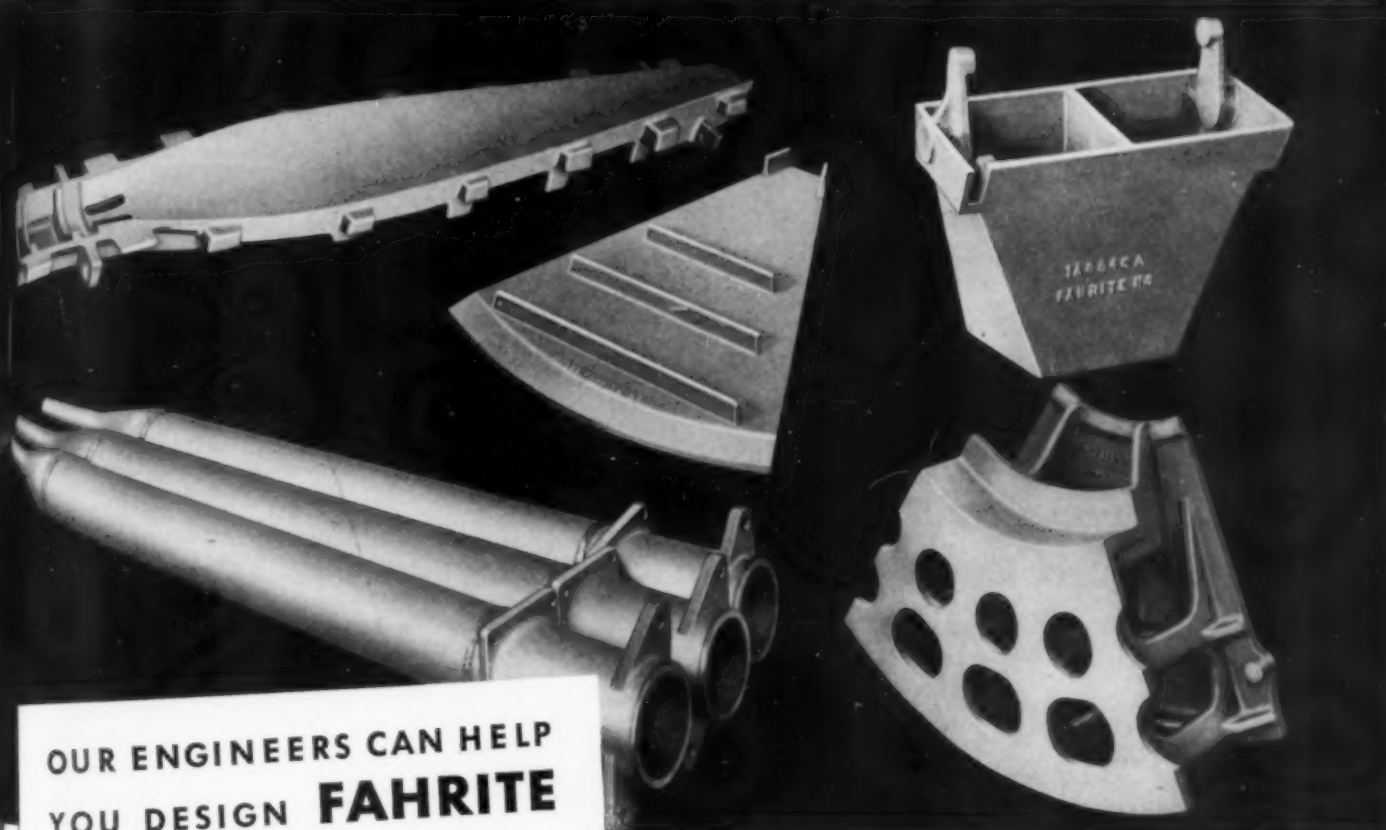
F. J. STOKES MACHINE COMPANY
6006 Tabor Road Philadelphia 20, Pa.

F.J.Stokes AUTOMATIC TABLETTING EQUIPMENT FJS Est. 1895

YOU CAN DEPEND ON

FAHRITE

HEAT AND CORROSION *Alloys*



OUR ENGINEERS CAN HELP YOU DESIGN **FAHRITE** PARTS WHICH MEET YOUR NEEDS EXACTLY

HERE ARE a few typical examples of castings made of FAHRITE, a special alloy of high nickel and chromium content, designed to withstand high temperatures at which ordinary steel would disintegrate by oxidation. FAHRITE castings are tailor-made for all purposes where permanent strength is necessary at elevated temperatures.

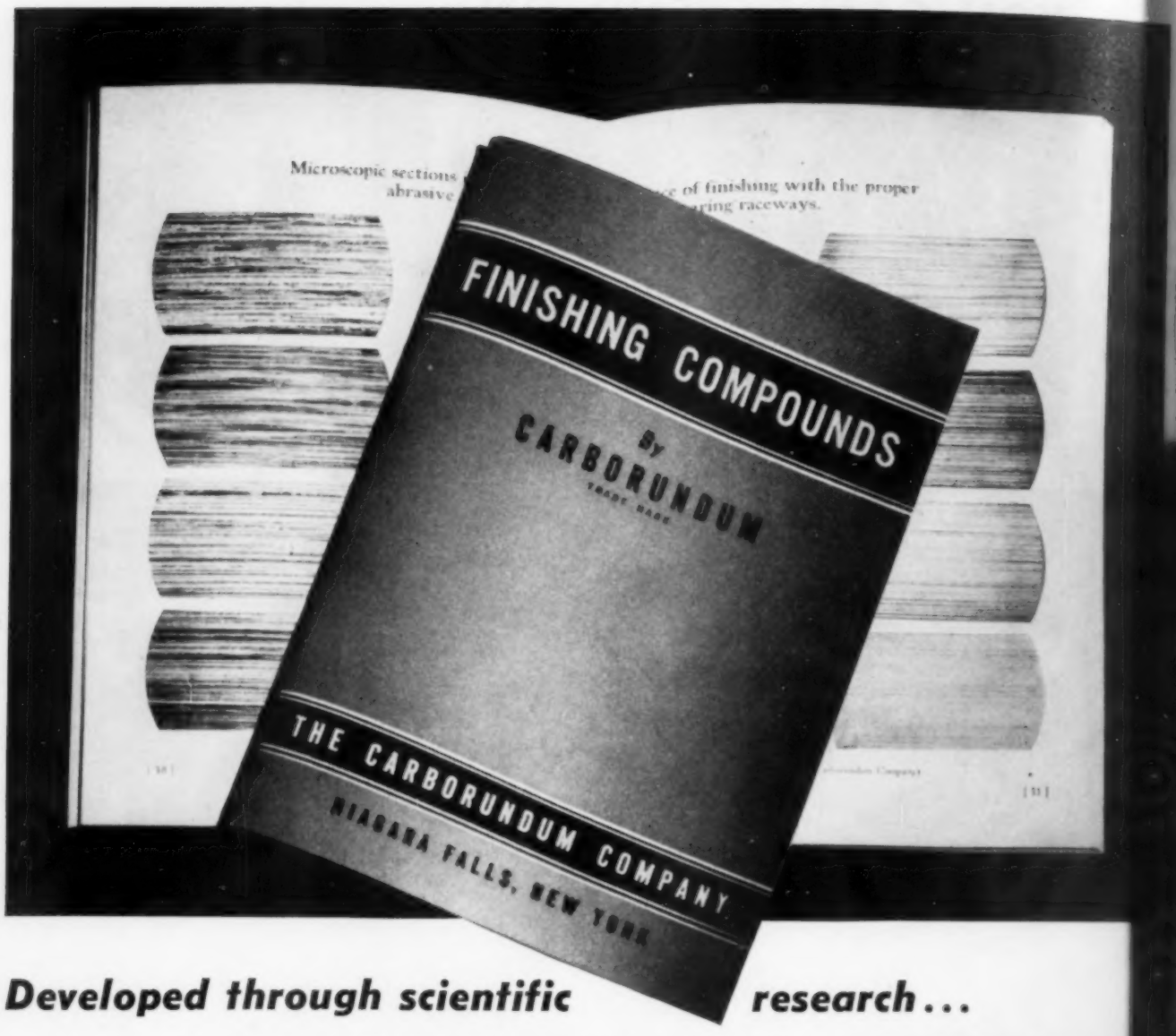
ARMY E NAVY

The Ohio Steel Foundry Company

LIMA AND SPRINGFIELD, OHIO

ENGINEERS • FOUNDERS • MACHINISTS

FREE ENTERPRISE IS THE ONLY WAY TO CONSTANTLY HIGHER AMERICAN LIVING STANDARDS



Developed through scientific research...

FINISHING COMPOUNDS BY CARBORUNDU

There was a time when the use of lapping mixes was pretty much a hit or miss proposition. The preparation of mixes was the result of individual judgment—there were no scientific methods used in the proper compounding of abrasive grain with oil or other carrier media.

But now Carborundum research has substituted science for guess work. Today, finishing compounds by Carborundum are the result of a close scientific study of the proper combining or mixing of abrasive grain and carrier—the development of carriers for specific finishing applications—the accurate grading of abrasive grain—the correct type of abrasive.

These compounds are produced in various grades to meet all conditions. Grit ranges are from 60 down to 1,000, the extremely fine powders being produced under microscopic control.

They are made with four types of abrasives—Carborundum Brand Silicon Carbide, Aloxite Brand Aluminum Oxide, the natural abrasive garnet and the diamond.

For complete details regard various grades—correct applicat and lapping procedure send cou today for new free booklet "Fini ing Compounds by Carborundu

The Carborundum Company
Niagara Falls, N. Y.

The Carborundum Company,
Niagara Falls, N. Y., Dept. MP
Please send my free copy of "Finishing Compounds by Carborundum":

Name .....

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Abrasive Products by CARBORUNDUM

Sales Offices and Warehouses in New York, Chicago, Philadelphia, Detroit, Cleveland, Boston, Buffalo, Pittsburgh, Cincinnati, St. Louis, Grand Rapids

(Carborundum and Aloxite are registered trade marks of and indicate manufacture by The Carborundum Company)

Grow 2 Fruits
ON ONE TREE?

It isn't impossible. Burbank did it. And it isn't impossible for Driver-Harris engineers to virtually double the furnace load in heat treatment operations . . . by devising improved load fixtures.

Here is one of many examples

This conventional nest of trays could handle only 48 gears. The aircraft engine manufacturer asked if D-H could increase the capacity within the same shell.

D-H specialists designed and cast this multiple spider fixture—and increased loading capacity to 84. Also, the D-H fixture makes loading from the side a simple matter.

[1] *In 1916, D-H designed the first nickel-chromium heat-treating fixture ever used. First patent was granted D-H in 1917.*

WE'RE FIRST[1] and foremost in devising and casting nickel-chromium heat-treating fixtures. D-H Nichrome* or Chromax* fixtures will speed your production and render dependable service *longer.* Bring us your toughest heat-treating problem. If it involves castings, we'll solve it.

**Trade Mark Registered.*

Driver-Harris
COMPANY
HARRISON, N. J.

BRANCHES: CHICAGO • DETROIT • CLEVELAND
LOS ANGELES • SAN FRANCISCO • SEATTLE

SPECIAL PURPOSE
ALLOYS SINCE 1899

BUILT TO BLAST

To meet the most destructive demands man ever has invented, American war materials exceed the dreams of scientists of a few years ago.

The strength, durability and indestructibility necessary in our materials to blast the Axis originate, in many cases, in the heat, chemical and annealing departments of plants, large and small, across the continent.

Many of these plants rely entirely upon the Pressed Steel Company to furnish them the last word in Annealing and Carburizing equipment—the job in which the Pressed Steel Company has been a leader for 20 years.

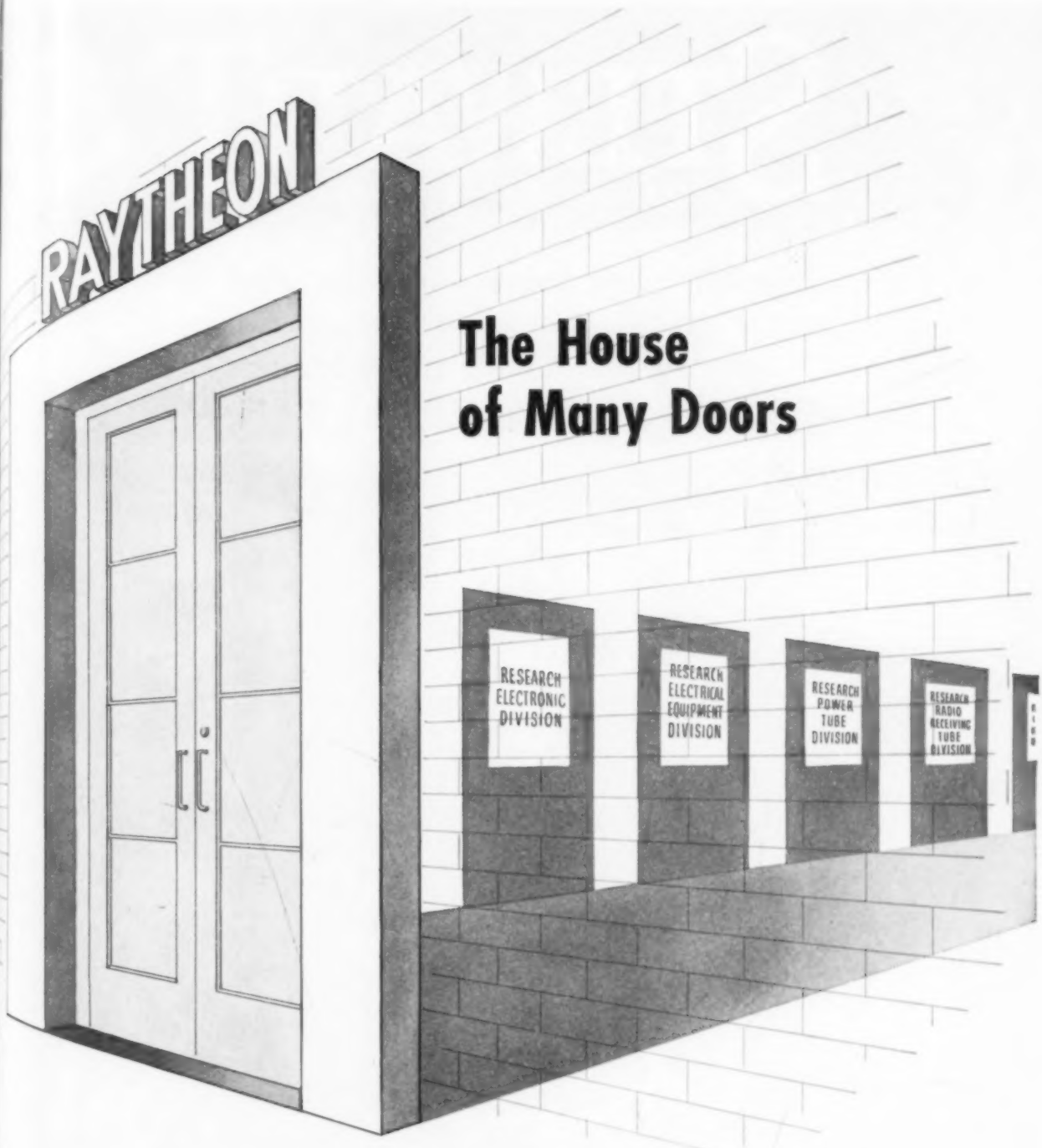
Such products are:

- Alloy Exhaust Manifolds
- Alloy Retorts
- Alloy Tubes
- Annealing Baskets
- Base Sheaths
- Annealing Covers
- Bubble Caps
- Carburizing Boxes
- Thermocouple Protection Tubes
- Cylinder Neck Rings
- Inner Covers
- Dipping Baskets
- Pickling Baskets
- Radiant Tubes
- Steel Cylinder Caps
- Tube Assemblies
- Tumbling Barrels
- Welded Alloy Tubing

New Pressed Steel Post-War products are on the way—every one of them weighing 70% less than old, clumsier types.

THE PRESSED STEEL COMPANY OF WILKES-BARRE, PA.

Branch Offices: 312 Curtis Bldg., Detroit; 606 Nicholas Bldg., Toledo; 1915 Engineers Bldg., Chicago; 51 E. 42nd St., New York; 1005 Sterling Bldg., Houston, Texas; A & M Accessories Ltd., 19 Melinda St., Toronto, Canada; Broad St. Station Bldg., Philadelphia.



The House of Many Doors

RAYTHEON is truly a house of many doors . . . doors that lead to many research, engineering, and production groups which have made great contributions to the quality and quantity of electronic equipment and receiving and transmitting tubes now helping the armed forces.

Today, behind these closed doors over 16,000 men and women are devoted to war work. Tomorrow, these doors will be wide open and through them will come new developments in all phases of electronics.

Tune in the Raytheon radio program: "MEET YOUR NAVY," every Saturday night on the Blue Network. Consult your local newspaper for time and station.

RAYTHEON
MANUFACTURING COMPANY
Newton and Waltham, Massachusetts

Devoted to research and manufacture of complete electronic equipment; receiving, transmitting and hearing aid tubes; transformers; and voltage stabilizers.

STEWART

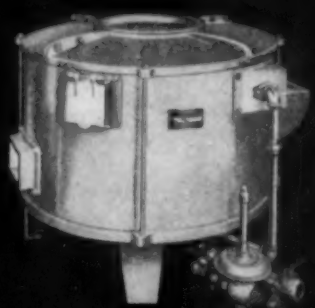
THE BEST INDUSTRIAL FURNACES MADE

A TYPE FOR EVERY NEED

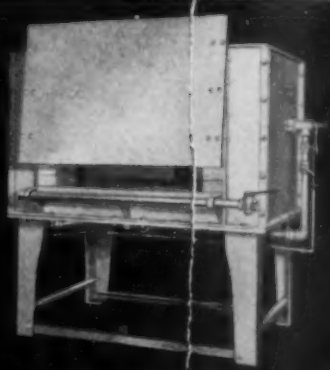
In addition to large units designed to meet specific production requirements, STEWART also builds these famous

STANDARD INDUSTRIAL FURNACES

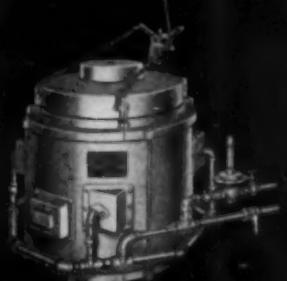
SEMI-MUFFLE OVEN FURNACE



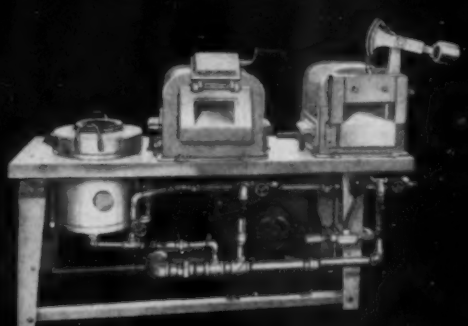
ROUND POT FURNACE



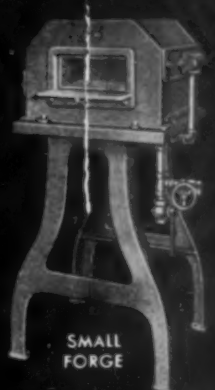
OPEN SLOT FORGE



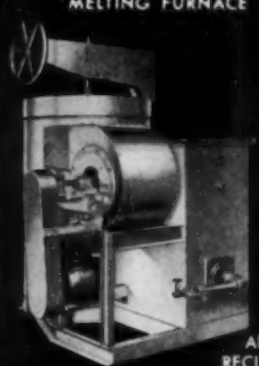
STATIONARY METAL MELTING FURNACE



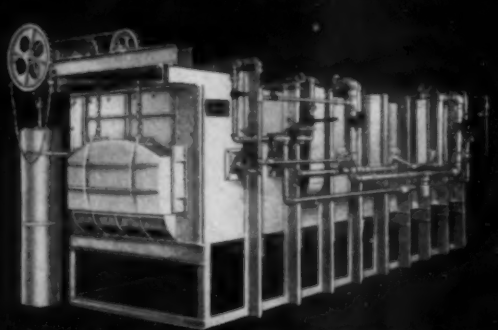
TRIPLE PURPOSE COMBINATION



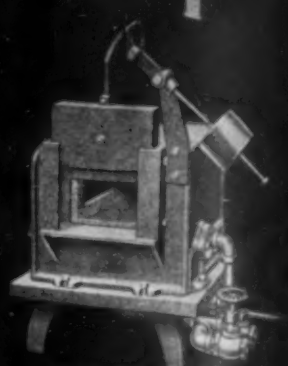
SMALL FORGE



AIR DRAW RECIRCULATING FURNACE



HEAVY PORTABLE OVEN FURNACE

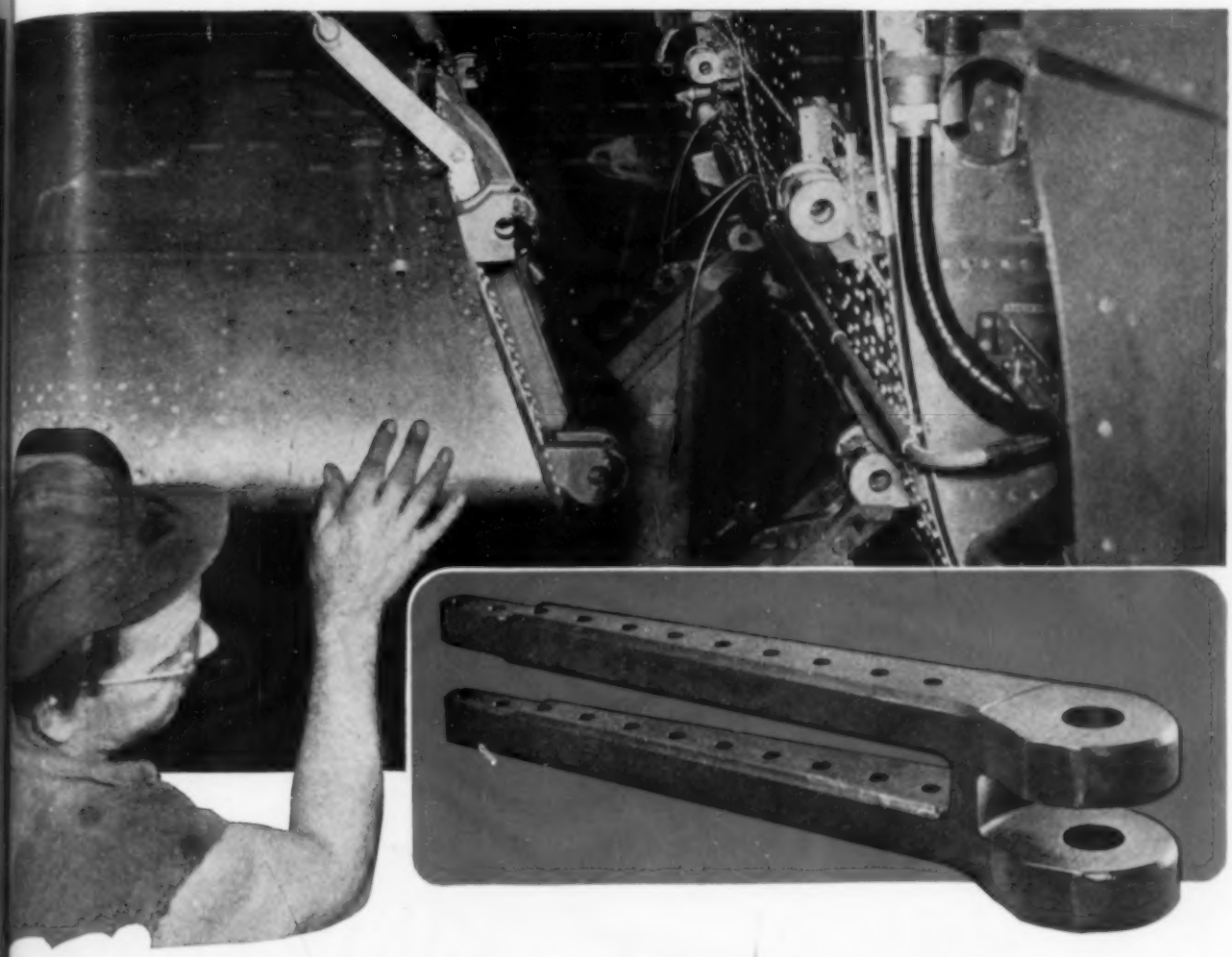


BENCH OVEN FURNACE

A letter, wire or 'phone call will promptly bring you information and details on STEWART Furnaces. Or, if you prefer, a STEWART engineer will be glad to call and discuss your heat-treating problems with you.

STEWART INDUSTRIAL FURNACE DIVISION OF CHICAGO FLEXIBLE SHAFT COMPANY

Main Office: 5600 W. Roosevelt Road, Chicago 50, Ill.— *Canada Factory:* (FLEXIBLE SHAFT CO., LTD.) 321 Weston Rd., So., Toronto



Extra Cost: *a Few Cents* . . Possible Savings: $23.00

Think of a 7-ton airplane diving faster than the speed of sound—and the tremendous strains exerted as the pilot pulls out of his dive.

Here is the hinge that holds the wings to the fuselage of one of our champion heavyweight fighting planes—the P-47 Thunderbolt. And it's made from Republic Electric Furnace Steel.

This fine steel has all of the strength, toughness and fatigue resistance needed to provide a high factor of safety. But more, it prevents lost time and money in production.

Steels made in Republic Electric Furnaces are as CLEAN and SOUND as the most expert furnace practice can make them. They are free from imperfections which might cause rejection at final inspection and the irrecoverable loss of all the time and labor expended.

This wing hinge, made from a 3 1/16" bar that costs about $2.00, has a final value of $25.00. Thus, the few extra cents spent for electric furnace quality is low-cost insurance against the loss of some $23.00 in production cost.

Republic Electric Furnace Steels enable manufacturers to derive greatest benefits from mass production methods—because they are consistently UNIFORM, homogeneous and free from practice-upsetting variables.

They hit narrowest physical, chemical, hardenability and workability specification marks repeatedly—because they are "targeted" by the close control possible only in the electric furnace.

And they can help you improve product quality or cut costs—help you prepare for keenly competitive markets. Republic—world leader in electric furnace steels—is ready to tell you how. Write us.

REPUBLIC STEEL CORPORATION

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GENERAL OFFICES • CLEVELAND 1, OHIO

Berger Manufacturing Division • Culvert Division
Niles Steel Products Division • Steel and Tubes Division
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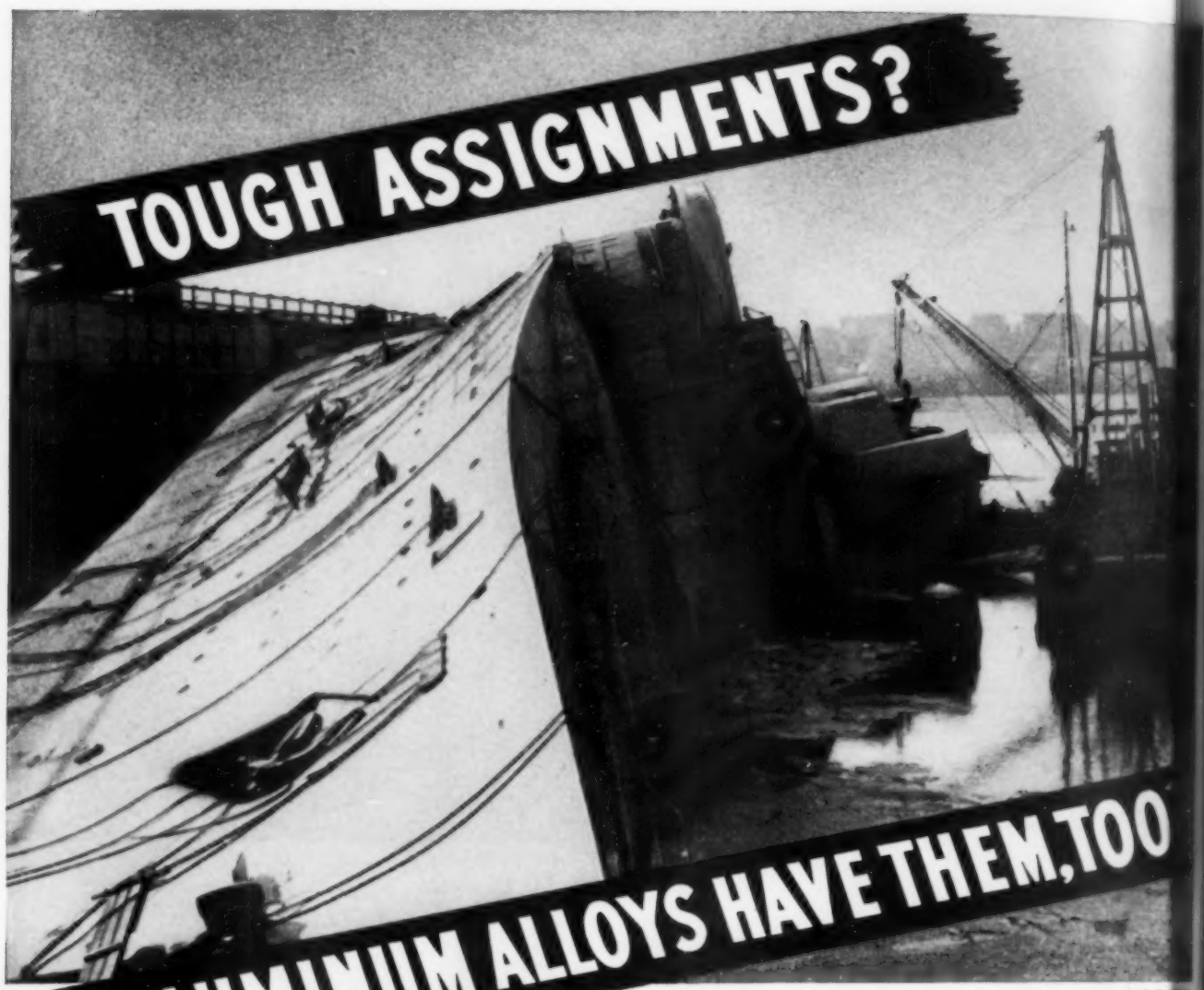
Export Department: Chrysler Building, New York 17, N.Y.

REPUBLIC

—Leader in the Production of

ELECTRIC FURNACE STEELS

"QUALITY" steels . . . alloy . . . stainless



ACME PHOTO

The righting of the Normandie was a tough assignment, but it proved an opportune school for training hundreds of Navy divers.

Aluminum Alloys furnished by us are also meeting tough assignments daily, such as the punishing service in aircraft, tank and marine engines. At the same time, other much smaller and more delicate parts made from our Alloys are functioning with extreme precision in an equally important, but less spectacular, manner.

In the production of the Alloys to meet these tough assignments, our forces, too, have found a valuable training ground . . . training which will be invaluable to you in your problems of post-war production.

The National Smelting Company
Cleveland 5, Ohio

Niagara Falls Smelting & Refining Corp.
Buffalo 17, New York

Sonken-Galamba Corporation
Kansas City 18, Kansas

U. S. Reduction Co.
East Chicago, Indiana

Aluminum and Magnesium, Inc.
Sandusky, Ohio

The American Metal Company, Limited
New York City 6

Apex Smelting Co.
Chicago 12, Illinois

Berg Metals Corporation
Los Angeles 11, California

The Cleveland Electro Metals Co.
Cleveland 13, Ohio

Federated Metals Division American Smelting and Refining Company
New York City 5 and Branches

General Smelting Company
Philadelphia 34, Pennsylvania

Samuel Greenfield Co., Inc.
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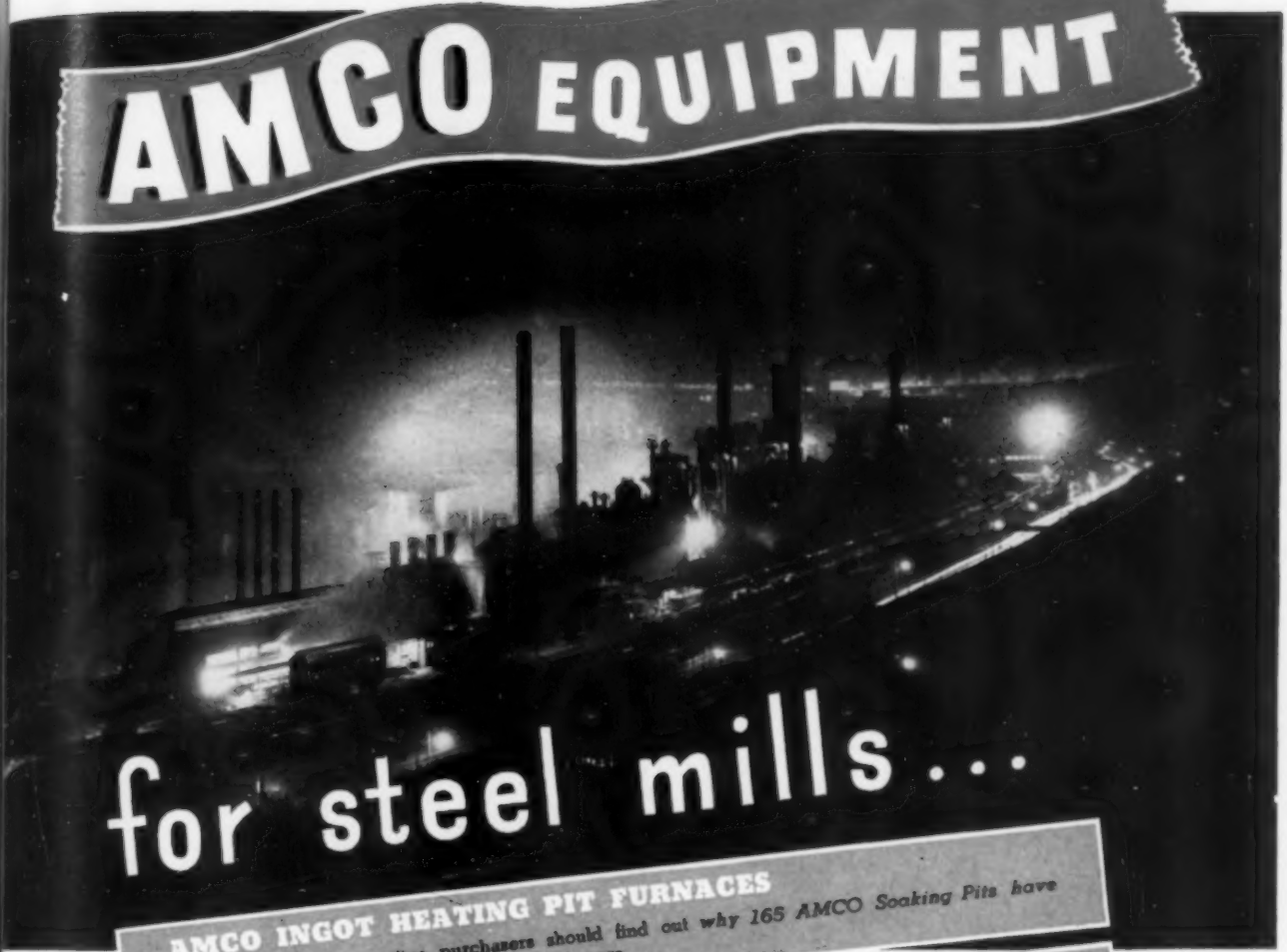
William F. Jobbins, Inc.
Aurora, Illinois

R. Lavin & Sons, Inc.
Chicago 23, Illinois

Aluminum Research Institute

111 West Washington Street, Chicago 2, Illinois

AMCO EQUIPMENT



for steel mills...

AMCO INGOT HEATING PIT FURNACES
Prospective purchasers should find out *why 165 AMCO Soaking Pits have been purchased* in recent years.

AMCO SIDE DOOR HEATING FURNACES
For reheating plate and forging ingots, slabs, and billets of all sizes—continuous doors where desirable.

AMCO CONTINUOUS PUSHER TYPE FURNACES
For reheating slabs and billets. Ingots *up to 17" thickness* successfully heated in charging-end-fired furnaces.

AMCO ALL REFRACTORY RECUPERATORS
More than 600 AMCO Recuperators installed in the steel industry during the past 8 years; preheated air temperatures up to within 700° F. of waste products temperatures.

AMCO OPEN HEARTH FURNACES
All sizes and types, complete with full automatic control and reversing.

AMCO PULVERIZED COAL SYSTEMS
Including long distance transport—for all types of industrial reheating furnaces.

AMCO ENGINEERING AND CONSTRUCTION SERVICE
Inquiries solicited for redesigning, rebuilding, relocating furnaces; dismantling, moving, erecting other heavy equipment.

The **AMSLER-MORTON** *Company*
FULTON BUILDING · PITTSBURGH, PA.

5

PAGE *Welding* ELECTRODES

NEW!

for AC *or* DC

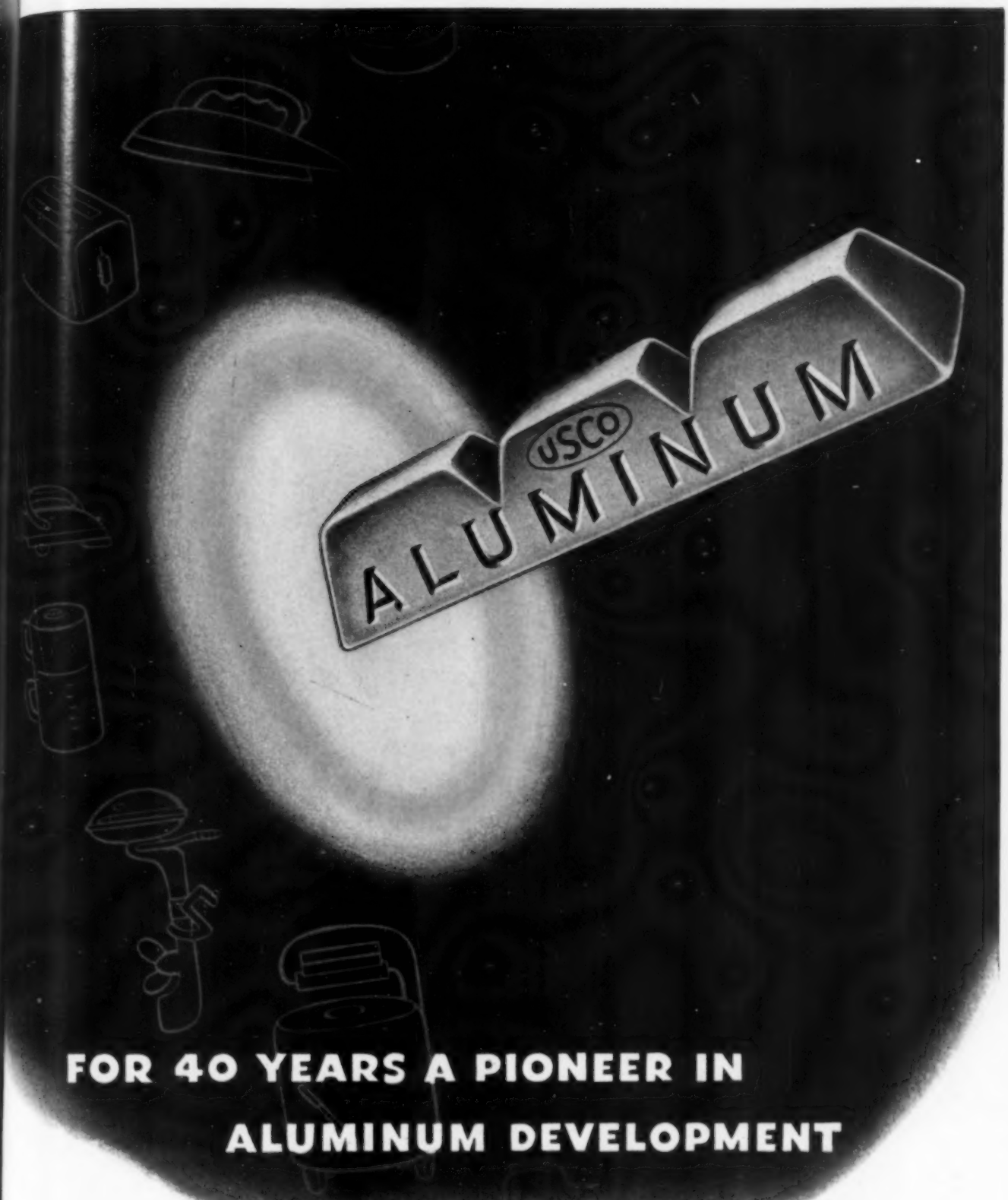
Here's the newest member of the **PAGE** Electrode family. It is a general-purpose electrode, especially designed for welding light-gage mild steel in flat, vertical, overhead and horizontal positions with either alternating or direct current. The **PAGE HI-TENSILE AF ELECTRODE** produces an exceptionally smooth and uniform bead, slightly convex. This makes it most satisfactory for fillet and lap welds. For further details about this new electrode, get in touch with your **PAGE** distributor.

PAGE STEEL AND WIRE DIVISION
Monessen, Pa., Atlanta, Chicago, Denver, Los Angeles, New York, Pittsburgh, Portland, San Francisco

AMERICAN CHAIN & CABLE COMPANY, Inc.
BRIDGEPORT • CONNECTICUT

ESSENTIAL PRODUCTS • TRU-LAY Aircraft, Automotive, and Industrial Controls • TRU-LOC Aircraft Terminals • AMERICAN CABLE Wire Rope • TRU-STOP Brakes • AMERICAN Chain • WEED Tire Chains • ACCO Malleable Castings • CAMPBELL Cutting Machines • FORD Hoists, Trolleys • HAZARD Wire Rope • MANLEY Auto Service Equipment • MARYLAND Bolts and Nuts • OWEN Springs • PAGE Fence, Shaped Wire • Welding Wire • READING-PRATT & CADY Valves • READING Steel Castings • WRIGHT Hoists, Cranes • WILSON "Rockwell" Hardness Testers

In Business for Your Safety



FOR 40 YEARS A PIONEER IN ALUMINUM DEVELOPMENT

USCO . . . your assurance of quality aluminum alloy ingot and deoxidizing shapes produced to exact specifications and backed by over 40 years of experience.

USCO

U.S. REDUCTION CO.

EAST CHICAGO, INDIANA

for SPEEDING UP TEMPERING OPERATION

INDUSTRIAL HEAT TREATING FURNACES

For:

CARBURIZING
NORMALIZING
HARDENING
TEMPERING
CYANIDING
STRESS RELIEVING
ATMOSPHERE CONTROL
NATURALIDING
BRAZING

Thorough, rapid heat penetration of densest loads. Gases from Lansing burners are drawn from specially lined combustion chamber and circulated through work by high speed fan.

Rugged blower unit, mounted in vertical position, has oversize radial and thrust ball bearings. Blower system is self contained, accessible, and easily removed as a complete unit. Motor, installed away from heat, is protected and quickly serviced.

For more information on this new type of Industrial Heating Equipment, ask for Bulletin No. 410

LANSING ENGINEERING COMPANY 934-36 CLARK STREET LANSING 6, MICHIGAN

WHY MORE FORGINGS IN YOUR POST-WAR PRODUCTS ?

The advantages of the broader use of forgings have proved themselves in armament making to such an extent that the nation's forge facilities were taxed to their utmost during the peak war production period. These same advantages are being utilized by designers of postwar machines and equipment.

HIGH TENSILE STRENGTH

Forgings provide metals at their ultimate strength and toughness, with maximum resistance to tensional, torsional and compression stresses; obtained through controlled grain flow, resulting from the forging process. Forged parts also embody the high fatigue resistance which results in longer service life.

SAVINGS IN WEIGHT

The forging process produces maximum strength, permitting use of thinner metal sections, resulting in parts of less weight. Valuable space may also be saved. These are important considerations in many postwar machines.

LOWER MACHINING COSTS

With the close tolerances obtainable by modern day methods, forgings generally require less time to machine and finish; resulting in reduced machining and tool costs.

GREATER SAFETY

The fracture of a part is too often accompanied by a serious accident. The use of forgings for stressed parts affords the highest safety factor.

At Kropp Forge, facilities for essential civilian forgings are becoming available as our war assignments are completed.

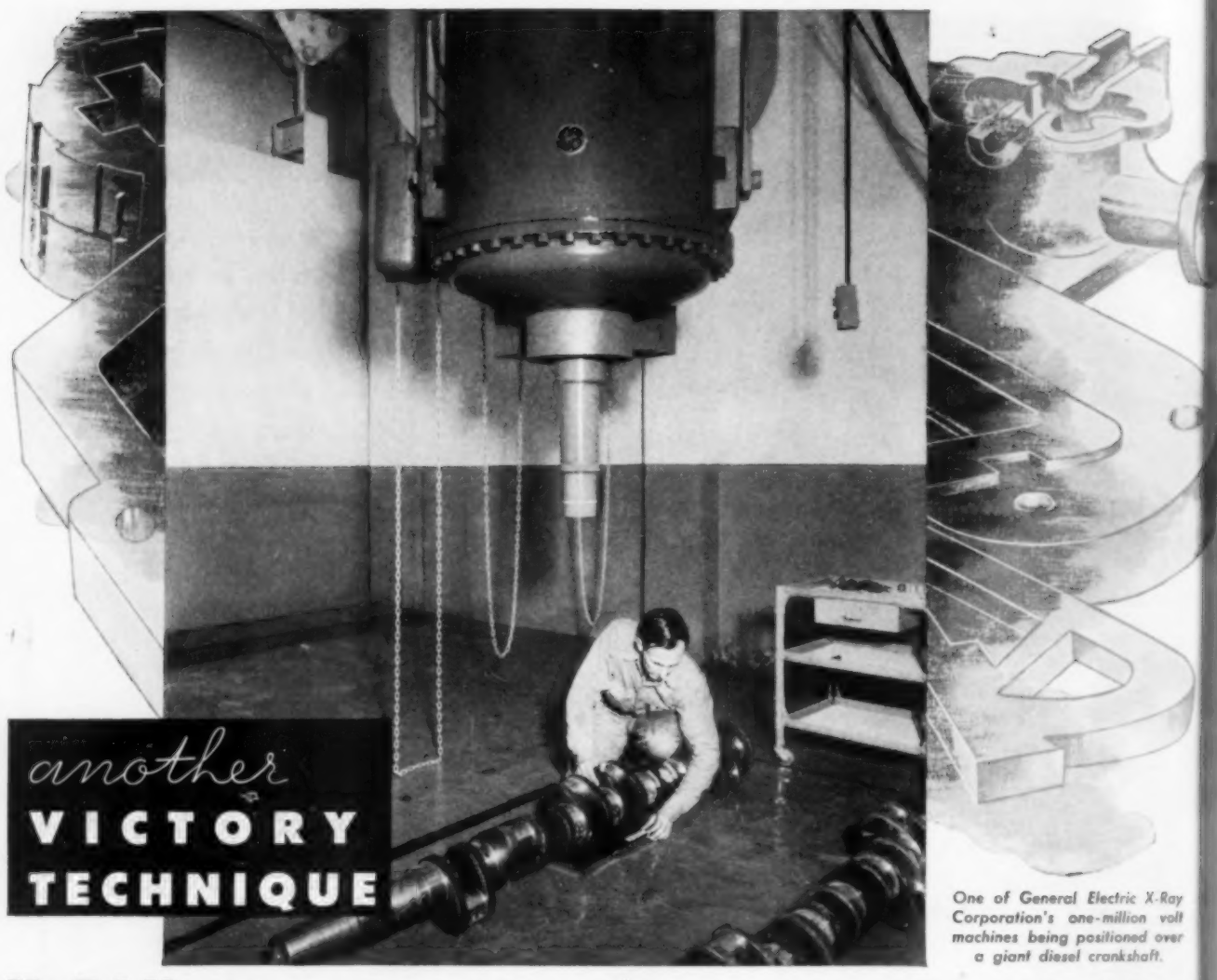
When you need flat die, drop or upset forgings, call the nearest Kropp engineering representative, or write direct for information or quotation.

KROPP FORGE COMPANY
5301 W. Roosevelt Road, Chicago 50, Ill.
Engineering Representatives In Principal Cities

SERVING INDUSTRY 18 SINCE 31 OVER 100 YEARS — KROPP FORGE CO

KROPP

ARMY ★★ E ★★ NAVY



another
VICTORY TECHNIQUE

One of General Electric X-Ray Corporation's one-million volt machines being positioned over a giant diesel crankshaft.

X-RAY NOW REVEALS HIDDEN SECRETS OF METAL

Most mysterious of new war-promoted metallurgical processes, the inspection of metallic structures by ever-more-powerful x-rays is one of the most practical. Inspired by the demands of army and navy, the production of all kinds of war equipment and munitions thus has not only been speeded up to unheard of proportions but safety and dependability in performance have been increased many times over.

Making spot checks on castings, developing routine casts, inspecting welds, or operating on a production line basis, x-ray machines powered up to two-million volts are giving certainty to a metallurgy previously working in the dark.

One out of many Victory Techniques that are helping to win the war, the new x-ray technique is typical of the processes, treatments, methods and assemblies that industry must adopt in order to produce competitively in peacetime at low cost and make jobs for everybody. *You must learn what these new techniques are.* Talk with the experts who call on you—your machine-tool man, your electrical equipment representative, your contact people for materials and services of every kind.

Your Lindberg Furnace representative can help you in ways you may not suspect. Invite him to talk freely about your metallurgical problems.

LINDBERG ENGINEERING COMPANY
2448 WEST HUBBARD STREET, CHICAGO 12, ILLINOIS

ARMY E NAVY

Lindberg FURNACES

SUPER-CYCLONE for hardening, normalizing, annealing, tempering
CYCLONE for accurate, low-cost tempering and nitriding
HYDRYZING for scale-free and decarb-free hardening

FOR GOOD *Production* AND USE *Performance*...

Red-X ALUMINUM ALLOYS

An important advantage of Red-X Alloys in the production of such critical parts as engine cylinder blocks, crankcases, and cylinder heads, is the fact that their carefully developed composition affords good castability. This results in greater freedom from defects, such as shrinkage porosity, cracks, and so-called cold shut or welds, and provides castings of desirable physical properties.

Used in automotive, marine, and railroad fields, as well as in armament for all branches of the Services, Red-X Alloys are noteworthy for uniformly satisfactory performance.

If you want Aluminum Alloys that will provide good production and use performance along with economy, inquire about Red-X Alloys—today.

THE NATIONAL SMELTING CO.
6710 GRANT AVE. • CLEVELAND 5, OHIO

Subassembly view of Ford V-8 tank engine showing the crankcase and cylinder head, both of which are made of Red-X Alloy

Write For A Copy Of This Booklet

NATIONAL SMELTING

"One test is worth a thousand expert opinions"

– The Riehle Axiom

Pendulum load indication is more accurate and dependable because it operates on the natural laws of gravitation. This principle of operation is not affected by temperature changes or subject to metal fatigue.

Precision

HYDRAULIC TESTING MACHINES

. . . . have repeatedly demonstrated the practical truth in the words, "One Test is Worth a Thousand Expert Opinions." Because they have simplified the science of testing the physical properties of materials they are widely used throughout the wartime industries today. Here Riehle Testing Machines "ferret out" material weaknesses and defects; avoid failures before they occur. This technique of progressive testing on the production line and in research laboratories saves valuable machine and man-hours. Write for descriptive literature and quotations.

RIEHLE *HYDRAULIC TESTING MACHINES*

Riehle Testing Machine Division, American Machine and Metals, Inc.

EAST MOLINE, ILLINOIS

Other Products: IMPACT TESTERS • VICKERS HARDNESS MACHINES • BRINELL HARDNESS TESTERS • MEASURING INSTRUMENTS

WARNING TO FIRST-TIME USERS - - - -

DON'T LOOK FOR A JACK-OF-ALL-TRADES IN ELECTRONIC HEATING MACHINES

ELECTRONIC HEATING is rapidly outmoding many industrial heating processes because of its numerous advantages, recognized and acknowledged by all leading industries.

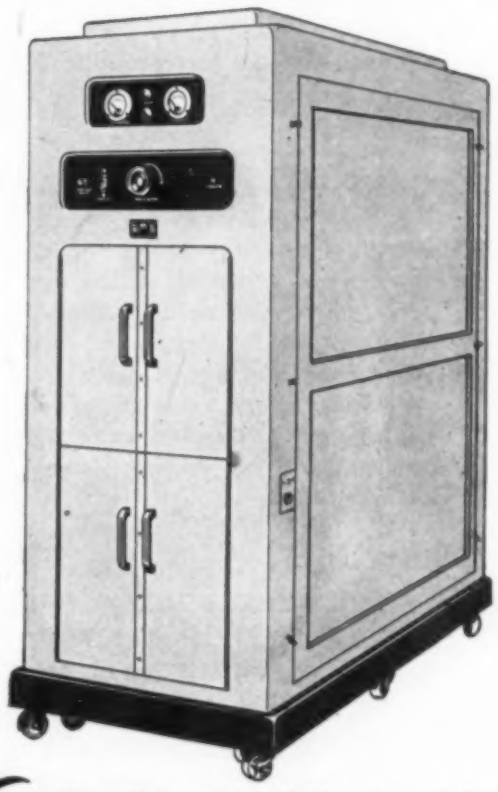
It is, however, important to realize that the maximum time-and-money-saving advantages of the process can only be realized by *using it correctly in every application.* Each heating process requires a definite FREQUENCY and POWER combination.

To use any combination of frequency and power other than the one ideally adjusted to the process implies a waste of power and the use of a "misfit" size machine.

No electronic heater has ever been built that can provide a range enough variety of frequency and power combinations to permit economical application to more than one type of heating operation.

For 23 years we have pioneered and specialized in electronic heating. As recognized experts we urge all first-time users to consult our engineers and to investigate the many advantages of our complete variety of units before buying. Write to us for detailed information.

Our equipment offers you a selection of frequencies up to 300 megacycles—and the following power range, with stepless control from zero to full load: 2, 7½, 10, 12½, 15, 18, 25, 40 and 100 Kw.



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DIVISION OF "S" CORRUGATED QUENCHED GAP COMPANY
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Manufacturers of Vacuum Tube and Spark Gap Converters
Since 1921

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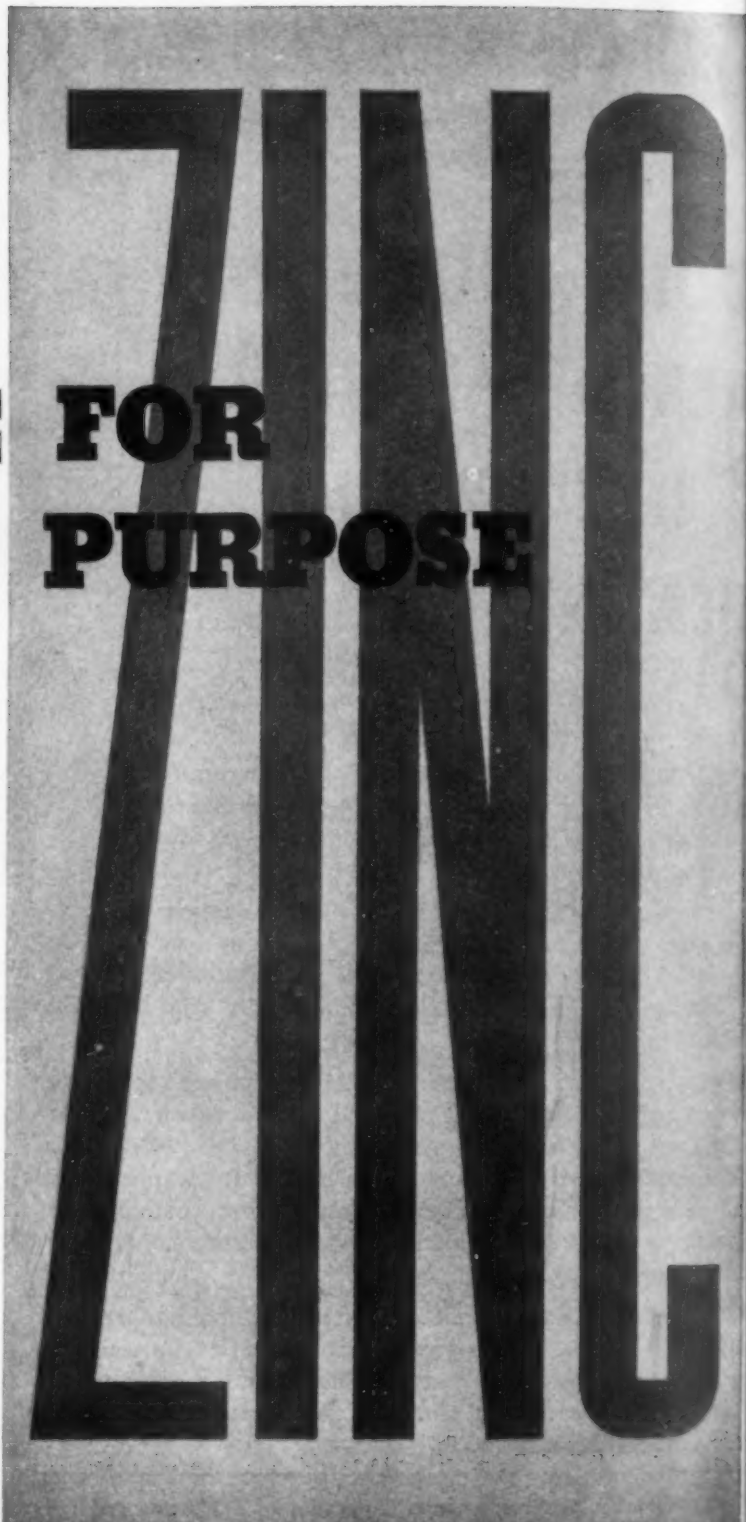

The quality of a die casting is in direct ratio to the purity of its base metal. When Bunker Hill, the first 99.99+% zinc to be produced commercially was placed on the market in 1928, the use of zinc base die castings expanded rapidly. The close control of quality which four-nine zinc made possible, is responsible for the fact that zinc is today the preferred base for die castings.

In addition to Bunker Hill 99.99+% Zinc, the St. Joseph Lead Company also offers to industry four grades of St. Joe zinc produced by its own patented electro-thermic process. Whether your requirements for zinc range from the highest grade for die-castings to the lower grades for hot dip galvanizing, this company has available for you a zinc for every purpose:

- BUNKER HILL SPECIAL HIGH GRADE
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a successful future for your product-

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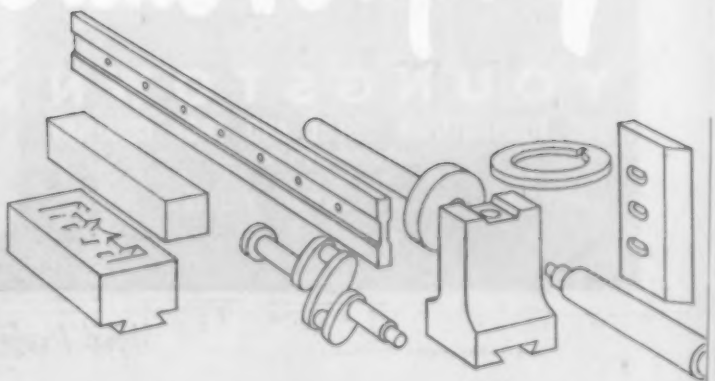
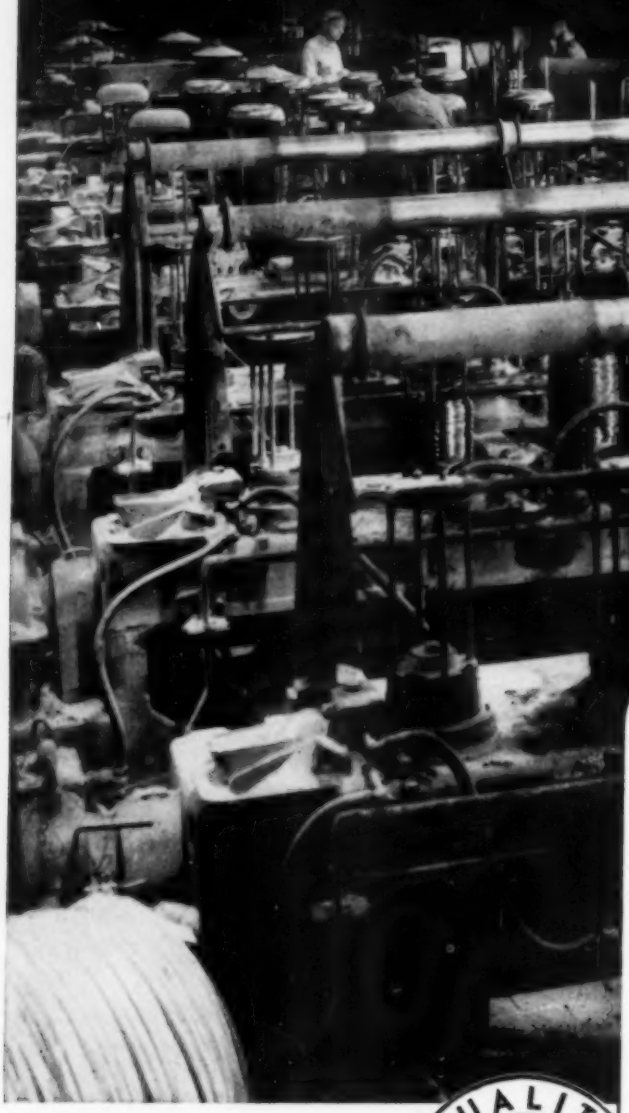
Among the unknown business factors of tomorrow, one thing is certain—better products will market quicker, in larger volume and at lower selling costs . . . Give *your* products proved sales appeal. Build *extra* strength and service into them. Incorporate forgings by Heppenstall and *know* that their service will sell your service . . . When you need alloy or carbon shafting, back-up roll sleeves, rings, shear knives, die blocks or alloy steel in ingot or billet, remember that Heppenstall makes the finest obtainable. In the vital parts of your own production equipment too, Heppenstall Forgings will save money, time and trouble. Heppenstall Company, Pittsburgh, Pa.



Makers of Heppenstall Automatic Safe-T-Tongs

Wire For Wire Rope



WIRE for wire rope keeps these Youngstown wire mills busy, day and night. In fact, America's wire rope needs are far greater than its capacity to produce. Wire rope by the millions of feet goes to tether barrage ballons, to lash cargo to ships, to equip every tank, truck and jeep with cable for binding on loads, for rescue work, etc.

Drawing wire for wire rope is a major activity at Youngstown, now as in peacetime, and manufacturing output is geared to the maximum of our ability to produce, yet quality supersedes volume with manufacturing standards maintained at the most exacting levels. Ready now to talk to you about your wire needs, present and future, we are equipped to meet your requirements, whether they call for standard or special specifications on chemical and metallurgical characteristics and physical tolerances.

Pipe and Tubular Products - Sheets - Plates - Conduit - Bars - Electrolytic Tin Plate - Coke Tin Plate - Rods - Wire - Nails - Tie Plates and Spikes - Alloy and Yoloy Steels.

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THE YOUNGSTOWN SHEET AND TUBE COMPANY

YOUNGSTOWN, OHIO

Manufacturers of

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When it's FIRE EXTINGUISHERS *instead of Flame Throwers*

Strict adherence to specifications for brass and other copper-base alloys produced by Western has enabled manufacturers to meet more successfully the problems of producing war materials. Our years of experience enabled us to meet these important requirements.

When the flames of war have burned out and attention is again turned to peacetime products, Western metals will be available in stamped parts, sheet, strip and long coils. New designs . . . possibly in fire extinguishers, as well as hundreds of other products . . . will require the workability, ageless beauty and long life of copper and related alloys.

The skill and facilities of Western's mills at East Alton, Ill. and New Haven, Conn., are at the disposal of all who work with metals or combine metal parts with non-metallic substances. We'll do our utmost to serve you well . . . now, or in the months to come.

Western BRASS PRODUCTS

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Division of WESTERN CARTRIDGE COMPANY, *East Alton, Ill.*

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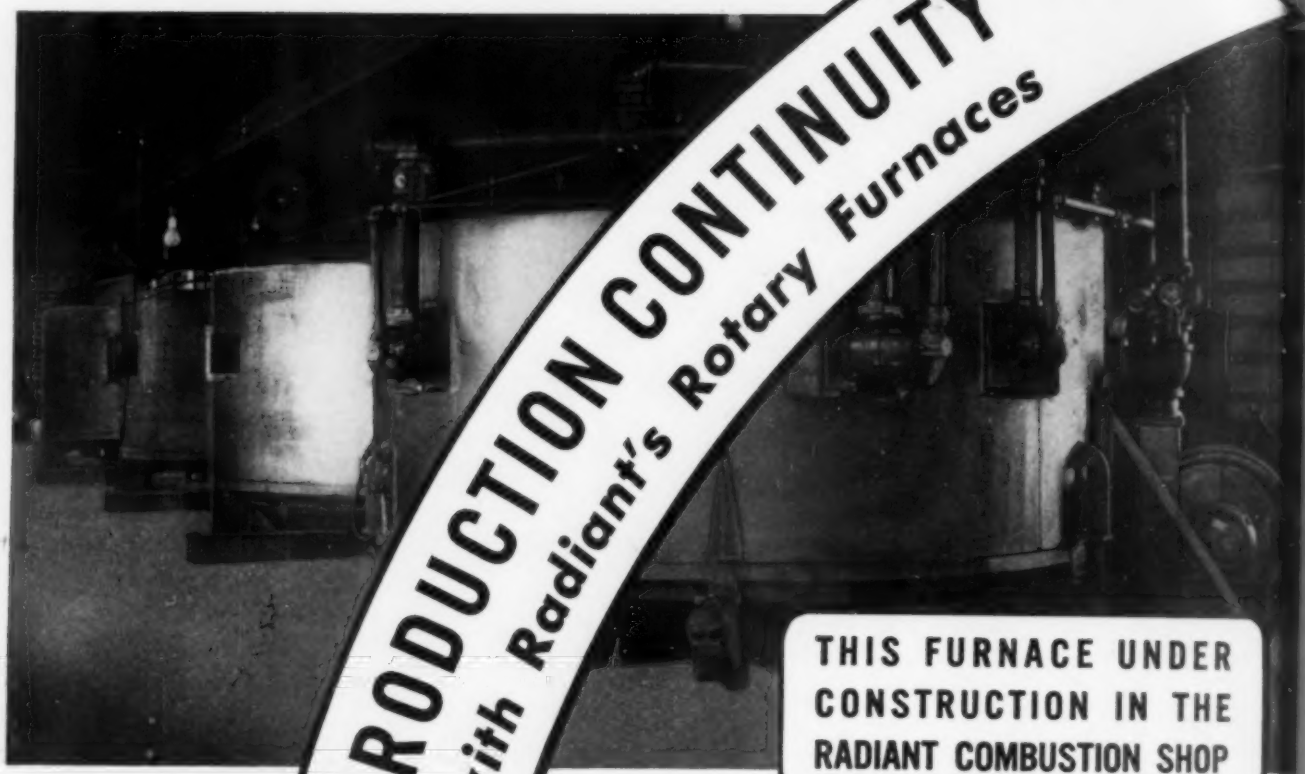

PRODUCTION CONTINUITY with Radiant's Rotary Furnaces

THIS FURNACE UNDER CONSTRUCTION IN THE RADIANT COMBUSTION SHOP

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Prompt attention to inquiries . . . On time furnace deliveries

Radiant Combustion, Inc

BUILDERS OF EVERY TYPE OF HEAT TREATING FURNACE

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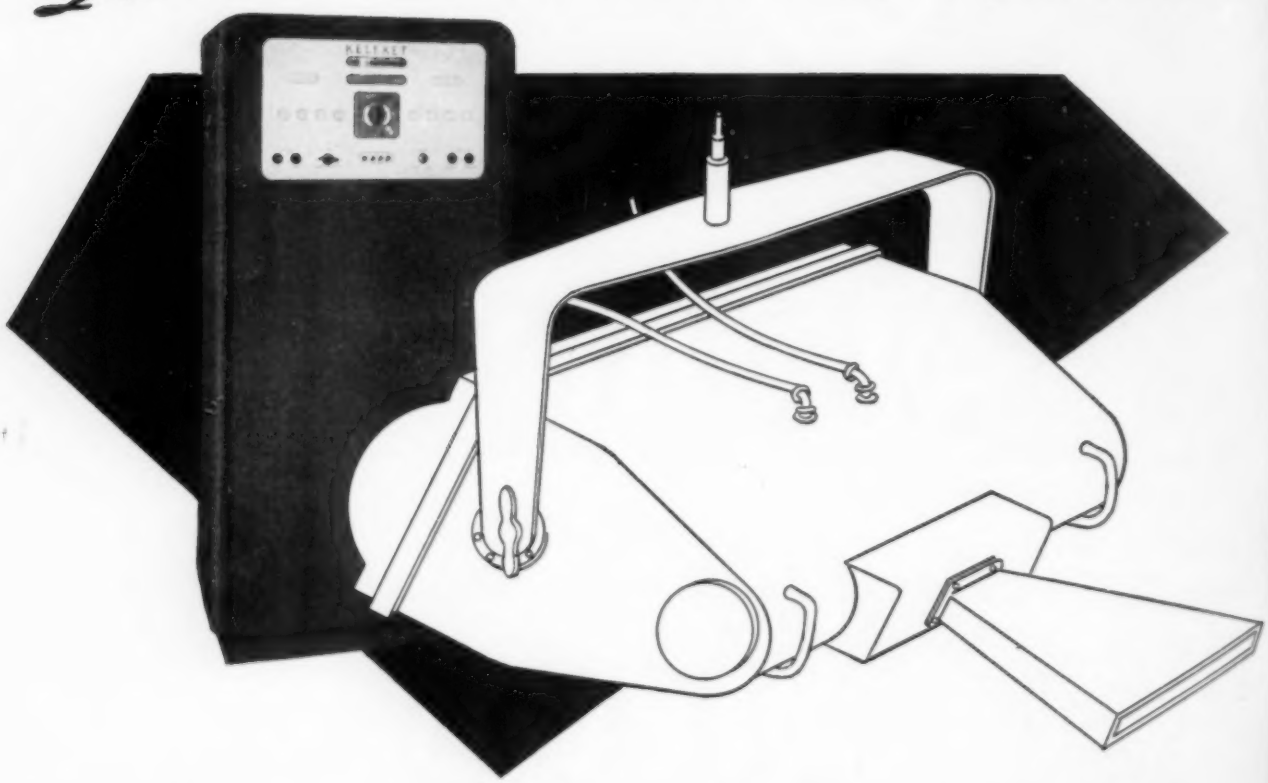
KELEKET *Introduces to Industry*

The 250 KV X-ray Inspection Unit



More Simple * More Dependable * More Efficient

Here's an important new industrial X-ray unit that has plenty of power and penetration to cover the widest range of inspection requirements—yet it is the easiest-to-operate X-ray apparatus produced today. Whatever can be done automatically *is* done automatically—the element of human error has been eliminated to the greatest possible extent. The *machine* does *more*—the *operator* does *less*—and *you* get better results.

A self-contained tubehead, with built-in oil cooler, eliminates separate transformers.

Stepless push-button control provides infinite kilovoltage selection.

Power is instantly and automatically shut off at maximum tube rating.

Pilot lights indicate—not only when there is trouble but shows where the trouble is.

Automatic safeguard permits radiation of X-rays only when cooling water is flowing.

Line compensator is adjustable while unit is in operation.

Constant milliamperage provided by inductive filament regulators and filament compensating transformers.

This 250 KV unit can be built into one of KELEKET'S radiographic production cabinets, can be furnished on hand truck, or mounted on either stationary or mobile jib crane.

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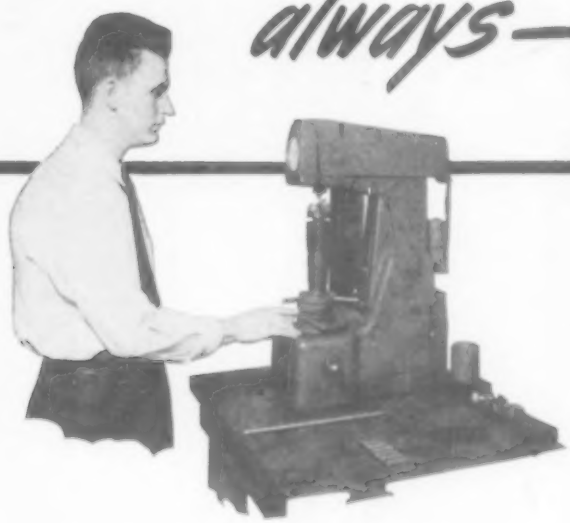
WYCKOFF COLD DRAWN CARBON & ALLOY STEELS

Controlled Quality always—



Because Wyckoff's advanced method of Heat Treating Cold Finished Bars eliminates many of the costly additional processing operations, and much of the expensive equipment involved,—many leading fabricators have adopted Wyckoff Heat Treated Bars for numerous operations where time must be saved and costs reduced.

Wyckoff metallurgists will gladly show you how sizable savings in steel fabrication costs can be effected in many of your present or post-war operations.

ARMY E NAVY

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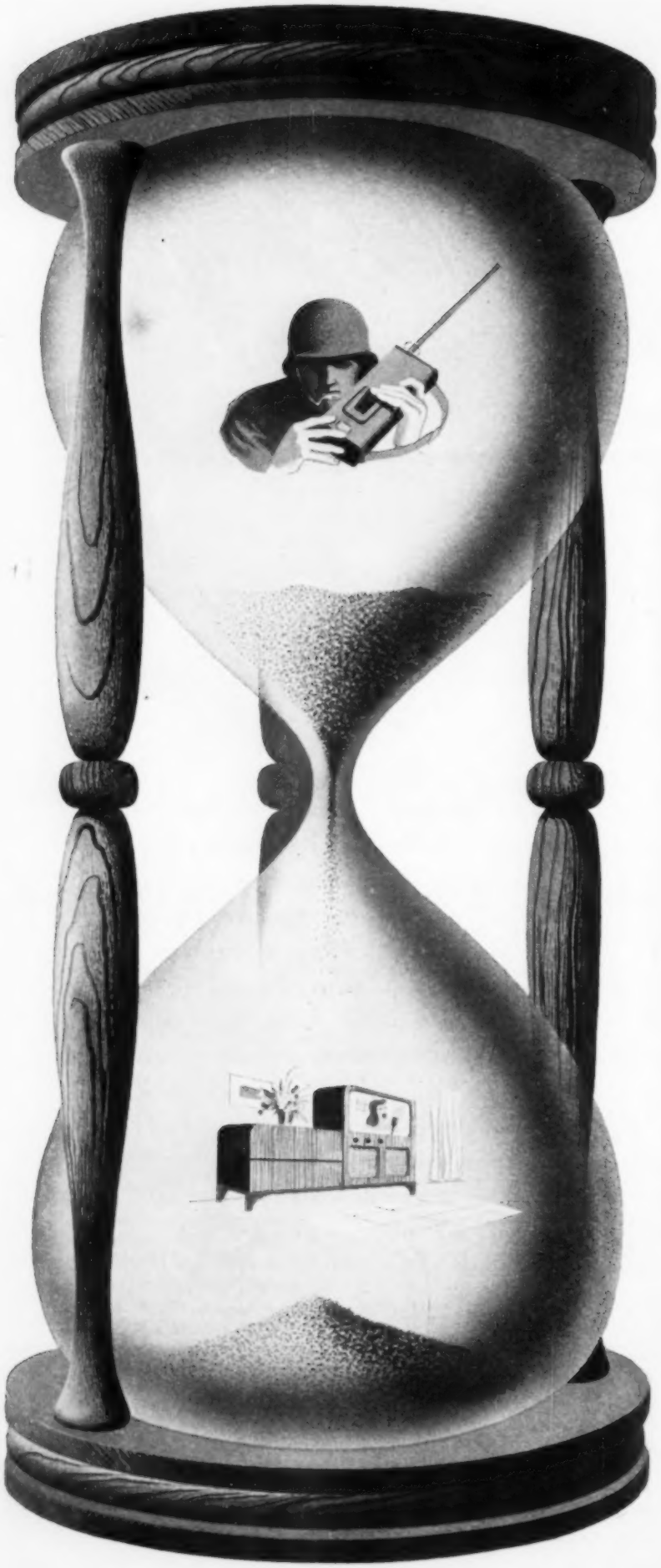

WILCO facilities Expanded to Meet Wartime Needs!

But Postwar Industry will be the ultimate gainer from the many new WILCO products and developments

As the Hourglass indicates . . . at the coming of peace, the skill and experience gained in the development and application of new WILCO products and techniques will mean much to automotive, electrical appliance and many other types of manufacturing customers.

Though now chiefly applied to the war effort, these new WILCO developments are destined to play as vital a role in the post-war industrial "comeback" as they are now playing in scores of wartime applications.

Thermostatic Bimetals, Electrical Contacts, and Precious Metal Bimetallic Products are such important factors in the precision performance of ships, planes, tanks, guns, and various instruments of the Army and Navy that the H. A. Wilson Company has found it necessary to enlarge its facilities and develop these important new products and techniques.

In the postwar period no company will be better equipped to meet individual requirements for Thermostatic Bimetals and Electrical Contacts on any desired scale than the H. A. Wilson Company, pioneers in this field.

WILCO PRODUCTS ARE: *Contacts*—Silver, Platinum, Tungsten, Alloys, Sintered Powder Metal. *Thermostatic Bimetal*—High and Low Temperature with new high temperature deflection rates. *Precious Metal Collector Rings* for rotating controls. *Silver Clad Steel. Jacketed Wire*—Silver on Steel, Copper, Invar, or other combinations requested. *Rolled Gold Plate*. Special Materials.

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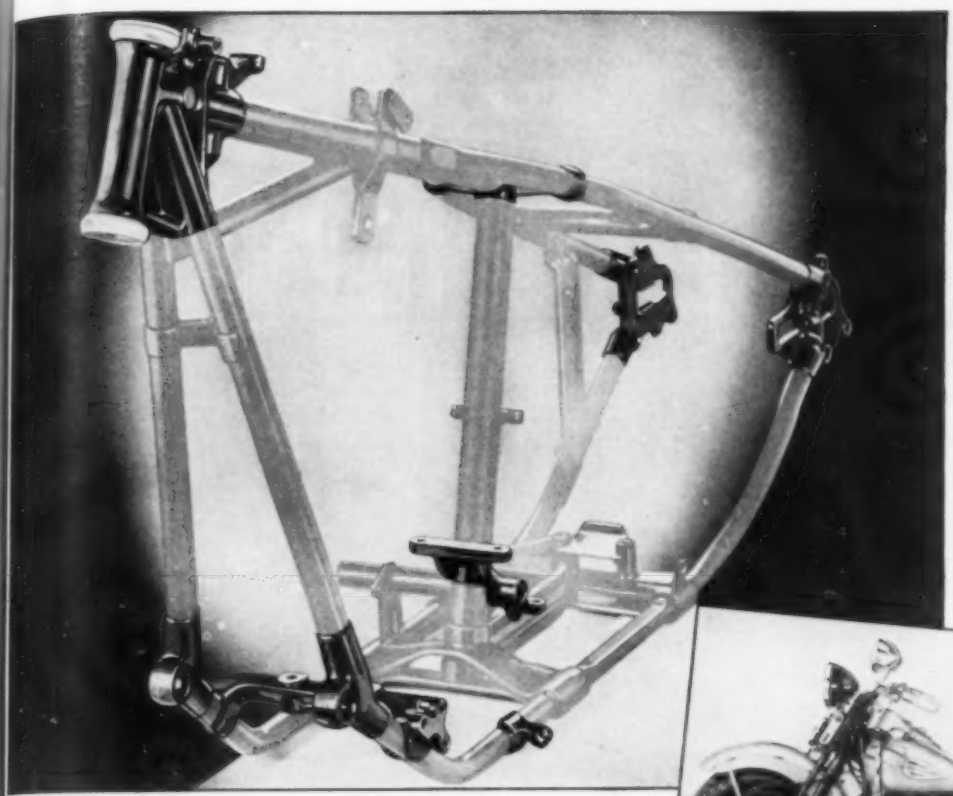
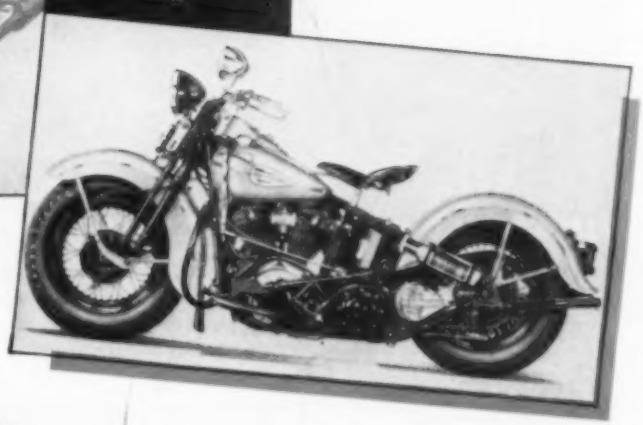


The famous Harley-Davidson Motorcycle. Phantom view of frame showing use of *drop forgings* at the points requiring maximum strength. . . . This model uses 29 drop forgings.



MAXIMUM *Strength* MINIMUM *Weight*..

WITH

INTERSTATE ENGINEERED FORGINGS

THE frame of a Harley-Davidson Motorcycle must combine maximum strength with minimum weight. Modern design accomplishes this by the use of *drop forgings* to which are welded or brazed the tubing or connecting members. Result—a one-piece, lightweight, but sturdy framework. This same principle is extensively utilized by manufacturers of aircraft, tractors, construction machinery, and by many other users of INTERSTATE Engineered Forgings.

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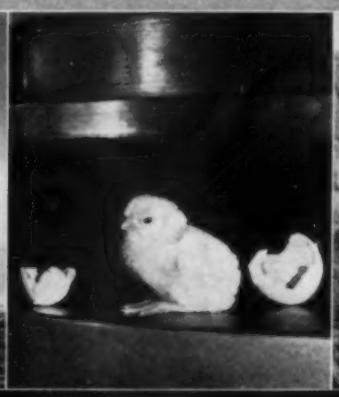
BALDWIN supplied the hydraulic elevators that raise and lower the stage of Radio City Music Hall.

BALDWIN diesel engines are used for main propulsion units on minesweepers and for auxiliary power on many other vessels.



BALDWIN testing machine of 3,000,000 pounds capacity can be controlled so as to break the shell of a hatching egg without harming the chick.

BALDWIN hydraulic turbines, 115,000 horsepower capacity, driving huge electric power generators, are installed at Boulder Dam.

Baldwin manufactures a wide diversity of products, including testing equipment for wind tunnels, steering gears for LST landing craft, hydraulic elevators for aircraft carriers, and many other machines and instruments, serving industry on which America is depending to speed final victory.

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BALDWIN

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How to Evaluate Insulating Firebrick

Consider:

1. Temperature Resistance
2. Light Weight for Low Conductivity
3. Stability
4. Volume Change
5. Manufacturer's Responsibility
6. Value

5

Manufacturer's Responsibility

The insulating firebrick that costs the least on a life-term basis—that will stand up longest in service—that will avoid preventable heat losses and fuel waste—can be selected by a method that is simple and reliable.

Consider the manufacturer's knowledge of insulating firebrick—how long he has made them. Investigate his knowledge of furnaces and the various applications of insulating firebrick. Determine his ability to produce high-grade products—uniformly—consistently. Then you can select the brick that will save money for you—that will minimize fuel costs, maintenance charges, and rebuilding expense, and will increase production.

Your local B&W representative will be glad to give information along the foregoing lines. He can also help with data on the five other checks you can make in selecting—with facts—the most economical insulating firebrick for you.

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SEAMLESS. Complete range of carbon alloy and stainless steels. Sizes: ½ in. to 8⅝ in. O.D.

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B&W MAKES BOTH

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HIGH SPEED STEEL

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The combination of great toughness and a high degree of hardness give MO-MAX superior cutting ability. This makes possible heavy cuts and the use of high speeds in a wide range of cutting operations.

Cutting tools made from MO-MAX, in actual tests, show 20% more work per grind per tool than those made from other steels. That advantage may be the difference between operating your machines economically or wastefully.

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This is not a booklet prepared primarily for selling purposes. Its 52 pages of sound, scientific facts trace the eleven-year development of molybdenum-tungsten steel. Photographs and graphic charts make the text easy to understand and gives operating and handling instructions for its proper use.

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A Big New Book Now Available
277 Illustrations — 550 Pages

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If you are a user of tool steels, here is the book for you — a practical, authoritative presentation of the facts you must have to do the job, to achieve the top results you must have today.

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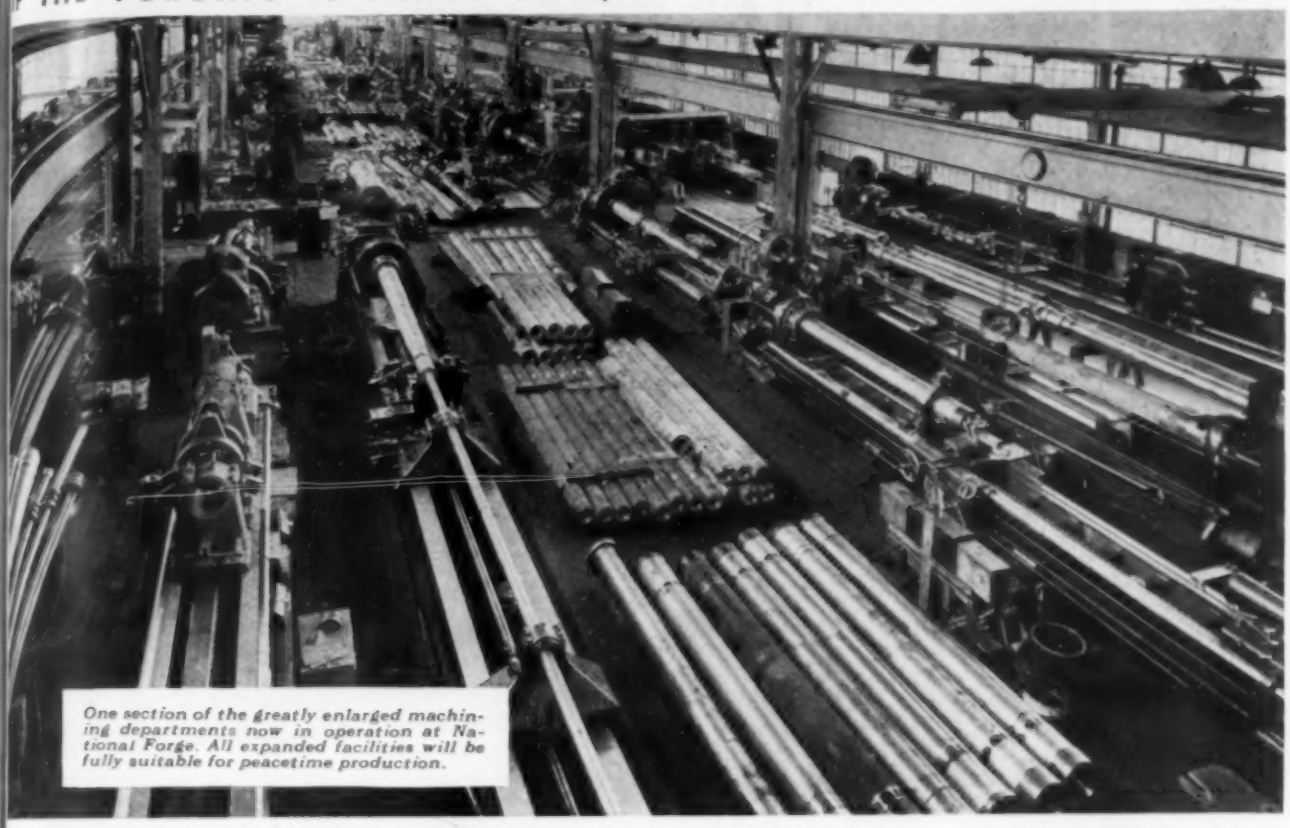
IF THE FORGING IS HEAVY DUTY, IT SHOULD BE NATIONAL FORGED



One section of the greatly enlarged machining departments now in operation at National Forge. All expanded facilities will be fully suitable for peacetime production.

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EVERY heavy duty steel forging has a big and often brutal job to do. And it is often work that calls for precision operation. Consequently it must be accurately machined to precisely fit equipment for which it is designed. National Forge has long held a high standing for precision craftsmanship.

"Precision checked by precision" is the constant watchword at National Forge, where every machined forging must pass the most exacting checks and re-checks before it is okay for delivery. Equipped with machine tools of great capacity and accuracy, manned by master mechanics trained in National Forge quality standards, the National Forge organization is as outstanding for its machining accomplishments as it is for the skill of its forge-smithing and the cleanliness of its steel making.

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National Forge has long held a preferred position for the accuracy of its internal boring and machining operations.

NATIONAL FORGE
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IRVINE, WARREN COUNTY, PENNA.
"WE MAKE OUR OWN STEEL"

For Excellence E *in Production*

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NITROGEN FLUXING

provides

Higher Quality Aluminum Castings

Safe and simple to use—costs less

It's no longer necessary to put up with troublesome methods, unpredictable results, noxious fumes to secure high-grade casting aluminum.

Bubbled slowly through the melt, non-toxic nitrogen removes hydrogen from metal solution, traps and brings to the surface minute bubbles of air and other gases and facilitates dressing. Thus pinhole porosity is reduced to a practical minimum, producing casting metal of excellent quality.

Results are not affected by atmospheric conditions. There is no loss of magnesium in aluminum-magnesium alloys.

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Many progressive foundries have tested and adopted this improved process as standard practice for producing highest grade aluminum castings.

The results of Airco engineers' extensive tests and research on nitrogen fluxing are always available through Airco field engineers and technical service to assure the successful functioning of the process.

Mail the coupon today for your free copy of the interesting folder "Nitrogen Fluxing of Molten Aluminum."

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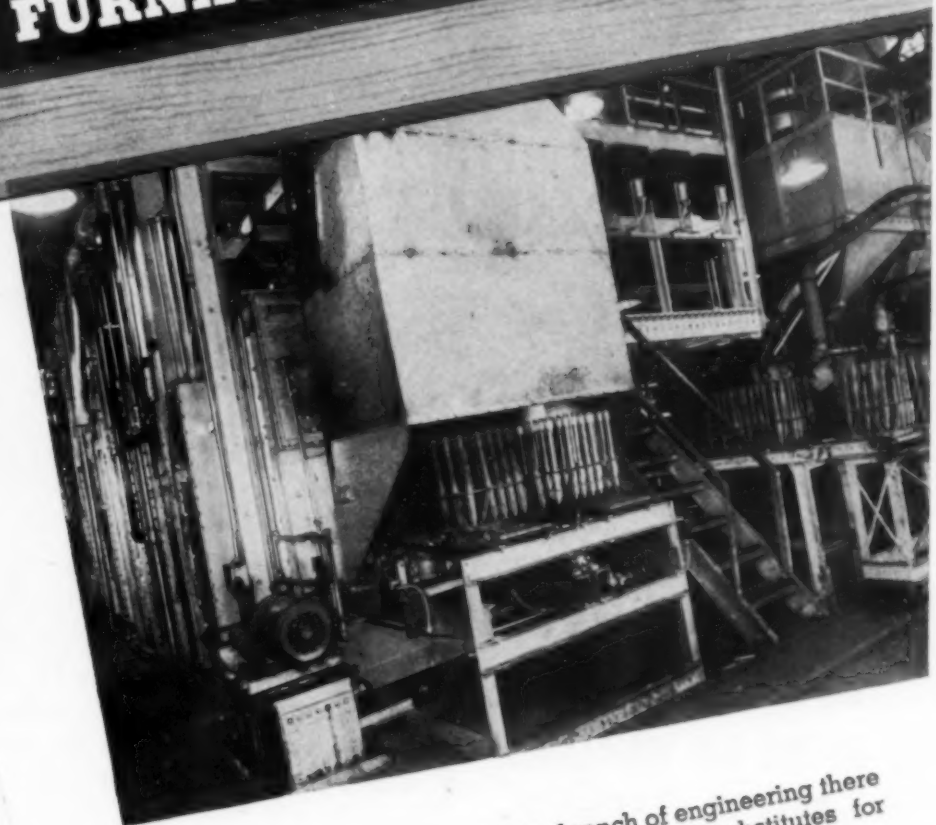
It takes 10 YEARS or more to develop a FURNACE ENGINEER



The *Difference* between a first-class heat treating furnace and a mediocre unit, judged by actual production results and operating costs, lies in the quality of engineering used in its design and construction.

It has been Holcroft's experience that 10 years or more of constant practice is necessary to develop a furnace engineer capable of maintaining Holcroft's standards. In this branch of engineering there are no short cuts—no substitutes for actual practice.

It is interesting to note that 43% of Holcroft's employees have been with the Company more than 15 years and 50% more than 10 years. When you buy a Holcroft Furnace you get all the advantages of this combined experience and know-how.

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NOV. 20th TO DEC. 16th

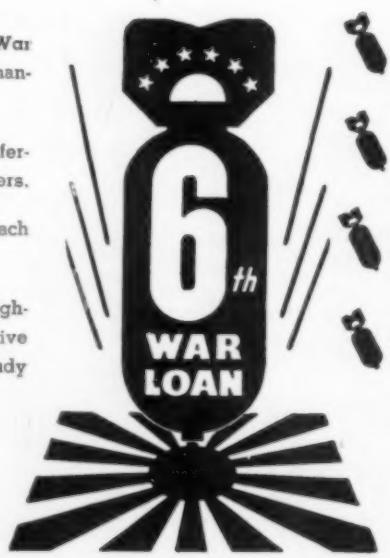
Our fighting men still have a long way to go! But—your plant-wide selling of the 6th can do much to shorten their embattled miles—lessen the price they so willingly pay for victory! Join the coast to coast parade of patriotic firms that are assuring an **"overboard" showing in the 6th** by following through on **every** point in the 8-Point Plan.

Start the ball rolling by appointing a **6th War Loan Bond Committee,** representing labor, management and other groups.

Carry on by selecting a **Team Captain**—preferably a returned veteran—for every 10 workers.

Right at the start, establish a **Quota** for each department—and every employee.

Arrange frequent **Meetings of Captains,** highlighting importance of their work—effective sales methods—and need for painstaking study of Treasury Booklet, Getting The Order.



Make definite **Assignments** to those best equipped to arrange music, speeches, rallies, competitive progress boards and meeting schedules.

Issue Individual Pledge Cards—made out in the name of each worker and providing for both cash and installment purchase.

Resolicit! This is the secret of "overboard" War Bond subscriptions. Your State Payroll Chairman has a special Resolicitation Plan for you to put into action near the end of the campaign.

Give generously of your **Advertising Space** to drive home the War Bond story.

The Treasury Department acknowledges with appreciation the publication of this message by

The American Society for Metals

★ *This is an official U. S. Treasury advertisement—prepared under auspices of Treasury Department and War Advertising Council*

BURNDY cuts Rejections to less than 1%

with LITHALOYS Master Alloys

Pure copper castings for Burndy HYLUG Cable Terminals with barrels machined. They weigh 9 pounds apiece, must be watertight and have maximum conductivity.

Terminal lugs must stand up under severe operating conditions which means that the castings *must* be right to start with. Several years ago, Burndy engineers adopted Lithium treatment as a positive means of maintaining their well-known high standards.

Before Burndy used Lithium Master Alloy, their rejections, after machining, ran over 25%—mainly due to porosity. Today, not only have rejections been reduced to an average of *less than 1%*, but Burndy standards, at the same time, have actually been increased with respect to strength, density and conductivity.

This is not an isolated case. Many others, even though their materials need not meet such exacting inspection, have found Lithium treatment profitable. Melts of copper, tin bronze and silicon bronze, treated with Lithium, yield castings more uniformly free from porosity and gas cavities...with non-metallic impurities effectively removed...and with optimum physical properties...at a small fraction of the cost of *one* reject.

And this treatment calls for no special equipment, no special training, no departure from conventional foundry practice. Shortly before pouring, Lithium metal is simply stirred into the melt in the form of a stable master alloy containing a small percentage of Lithium combined with other metals to match the melt.

To assist you in investigating this money saving treatment, we offer the use of our own casting facilities and the services of our technical staff —without obligation.

12-LC-1

LITHALOYS CORPORATION

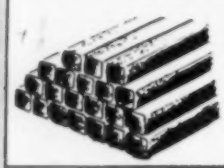
444 MADISON AVENUE, NEW YORK 22, N. Y.

FORGINGS POSSESS HIGH STRENGTH and TOUGHNESS

● Forging, or hot working metal, with closed impression dies directions the fiber structure, inherent in steel, to provide high strength and toughness where most needed to resist stress or shock. Maximum strength for a given amount of weight is just one of seven advantages that forgings offer.

These Are Other Advantages:

FORGINGS CONSERVE METAL



FORGINGS LESSEN SCRAP; UNUSUALLY FREE OF CONCEALED DEFECTS; PRACTICALLY NO REJECTIONS

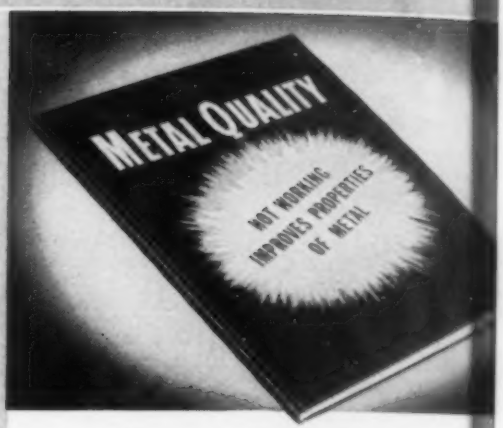
FORGINGS REDUCE DEAD WEIGHT THROUGH MAXIMUM STRENGTH IN LIGHTER SECTIONAL THICKNESSES

FORGINGS FACILITATE RAPID ASSEMBLY THROUGH WELDING ADAPTABILITY

FORGINGS REQUIRE LESS TIME TO MACHINE AND FINISH BECAUSE SHAPED IN CLOSED DIES

FORGINGS REDUCE ACCIDENTS TO MEN AND MACHINES THROUGH A GREATER MARGIN OF SAFETY

Are you obtaining the utmost benefit from your use of forgings? A recheck of every forged part you use against these advantages may reveal unusual benefits which have been unintentionally neglected or overlooked. Even manufacturers who have had long experience in the use of forgings have found further opportunities to *reduce weight, improve product performance and effect worth-while savings* by rechecking parts against these advantages. • Consult a forging engineer connected with your source of supply. His broad experience will be helpful to you in obtaining the utmost benefit from each advantage in your use of forgings.



This new booklet will help you to avoid misestimating the qualities required to meet a specific service condition. Metal quality can be developed to the exact degree required by the forging process, and this booklet presents many examples that prove it. It contains 40 pages of factual information about the development of maximum strength and toughness in forgings. Over 200 illustrations are used, most of them for the purpose of showing directioned fibre structure, or grain flow as obtained by forging. The booklet has been prepared for the guidance of design engineers, metallurgists and other technicians, production and management executives; whose task it is to determine the metal quality required for *safety and dependable performance*. Ask your source for forgings for a copy, or write direct.

Drop Forging Topics contains technical information for design engineers, production executives, metallurgists, and other technicians who specify and use metal parts for operating mechanisms. It is published ten times a year; usually contains 8 pages and is available upon request. Is your name on *Topics* mailing list?

DROP FORGING ASSOCIATION
605 Hanna Building • Cleveland, Ohio
Please send me:
☐ Booklet on "Metal Quality – How Hot Working Improves the Properties of Metal."
☐ "Drop Forging Topics," issued ten times a year.

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Company .....
Address ..... *City* ..... *State* .....
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DROP FORGING ASSOCIATION

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15 reasons why LEPEL INDUCTION HEATING offers you the fullest satisfaction

1. Remarkable flexibility – makes possible the use of a large variety of work coils of different sizes and shapes for many different jobs involving the heating of both ferrous and non-ferrous metals, *without requiring the use of matching transformers.*
2. Unity power factor at maximum output.
3. Water cooled transformer with exclusive Lepel arrangement for preventing condensation throughout the unit.
4. Either manual or fully automatic operation.
5. Instantaneous starting – no continuous current consumption – current required only during actual heating cycle.
6. Minimum water consumption – only two gallons maximum per minute on 30 KW unit; less on smaller units.
7. Normal water pressure adequate – only 20 to 25 pounds required – no filtering systems or auxiliary pressure pumps necessary.
8. Complete safety to operating personnel against all high voltage dangers.
9. Water pressure control switch prevents starting unless water supply is on, and automatically cuts off power in the event of water failure or water pressure drop.
10. Same unit suitable without any auxiliary equipment for hardening, annealing, stress relieving, brazing, soldering and melting – ferrous and non-ferrous metals.
11. Each unit fully self-contained, mounted on casters and readily movable.
12. Permits wide selection of power range from low to high in ten steps (30 KW unit).
13. Power input remains practically constant throughout entire heating cycle without regard to physical changes in metal being heated, such as passing from magnetic to non-magnetic stage or from solid to liquid state.
14. Lowest cost per KW of dependable performance.
15. Lepel is truly the pioneer – the first and foremost manufacturer of quenched spark gap induction heating equipment.

Only Lepel Units combine ALL these features

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PIONEERS IN INDUCTION HEATING
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- how to select and heat treat the right tool steel for the job
- improve tool performance and cut costs
- save time and money in the toolroom
- the relation of design to heat treatment
- trouble shooting
- testing procedures

TOOL STEEL SIMPLIFIED

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Vice-President of
The Carpenter Steel Company
315 *Pages* 205 *Illustrations*
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Filled with practical information, by combining the steel maker's knowledge with tool making experience, TOOL STEEL SIMPLIFIED provides the answer to many of your toolroom problems. In easy-to-understand shop language, it explains the basic principles of good tool making so clearly and simply that it is the standard training book in hundreds of important plants. At the same time it offers the experienced man a valuable reference guide to check on every phase of tool and die making — steel selection, heat treating, furnace atmospheres, quenching, etc.

Widely used by many companies and trade schools throughout the United States, it meets the need for an authoritative, inexpensive, trade handbook for all those who are responsible for the design, making, or heat treating of tools. Send for your copy today.

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MAGNET STEELS—ROLLED AND CAST

WRITE FOR MAGNET STEEL BOOKLET

SIMONDS SAW & STEEL CO., LOCKPORT, N.Y.

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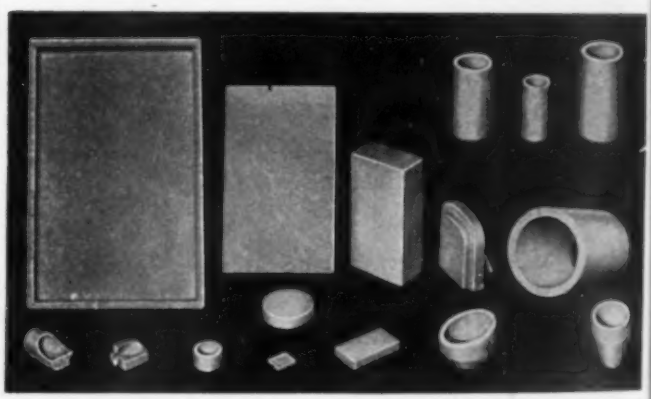

WESGO SUPER REFRACTORY slabs, boats, blocks, crucibles and other shapes stubbornly refuse to crack or spall, no matter how cataclysmic the temperature change.

IN FACT—no other non-metallic material will withstand as much thermal shock at high temperatures.

Wesgo shapes retain their virginity by refusing to associate with hydrogen, cracked ammonia and other furnace gases in spite of the opportunity created by intimate contact at high temperatures.

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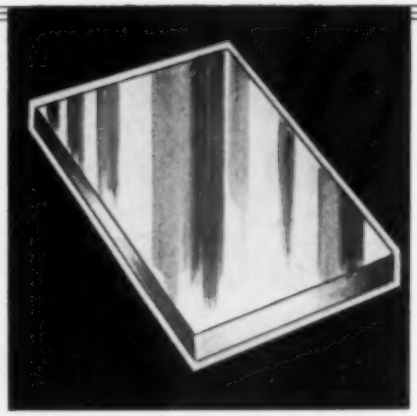

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Expanding the services rendered by our Technical Department, at Cambridge, Massachusetts,

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fully equipped for metallurgical and chemical research with furnaces (high frequency, nitriding, heat treatment), hydraulic presses, etc.

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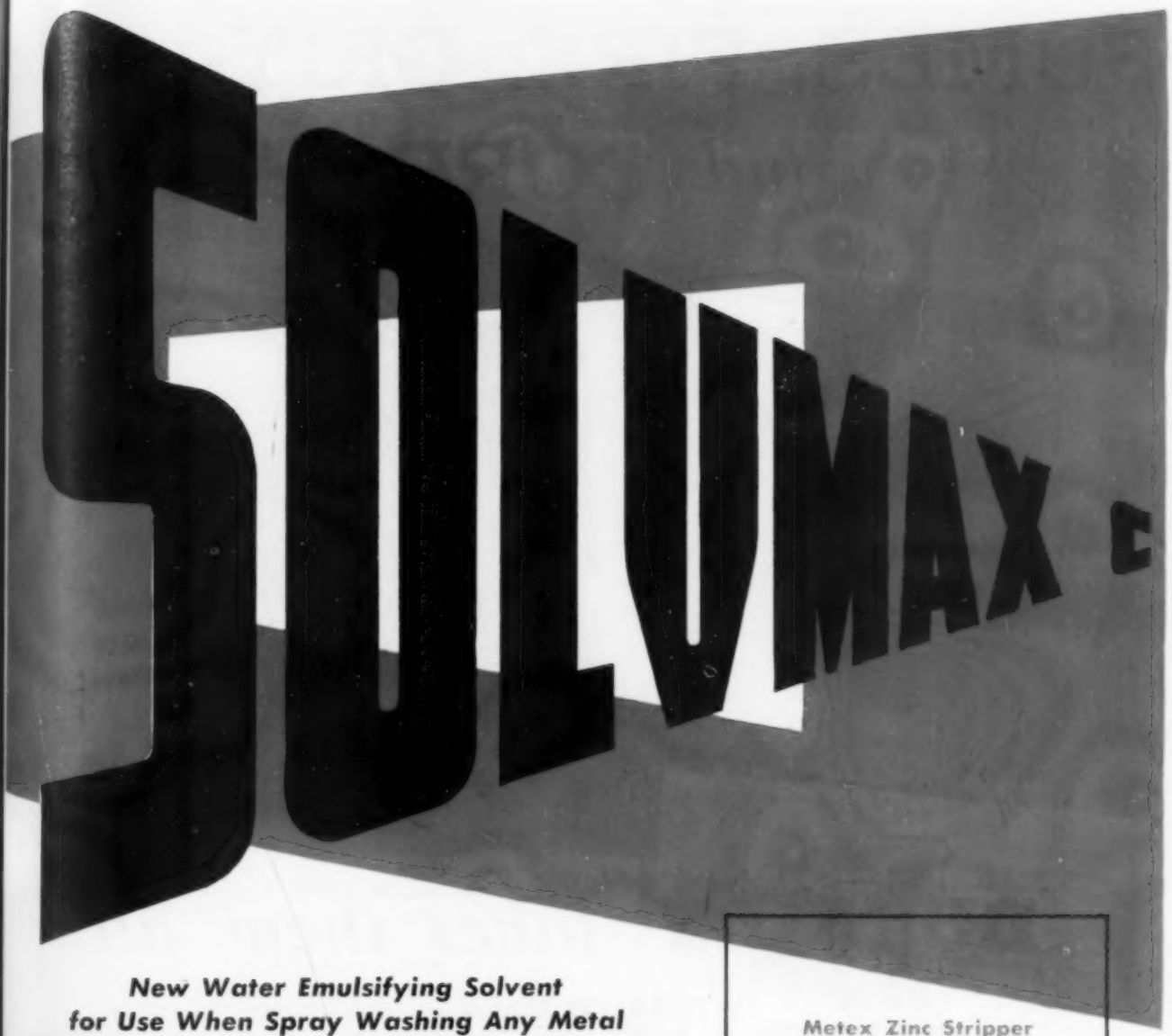

New Water Emulsifying Solvent for Use When Spray Washing Any Metal

SOLVMAX C, considered by many to be the hardest hitting, fastest acting and most economical water emulsifying solvent ever offered. Among its many features are . . .

Is non-corrosive even if not rinsed from any metal.

Will remove magna-flux, carbon smut, graphite and inorganic contaminations through use of a room temperature water solution.

Removes buffing compounds, oils, drawing compounds.

Produces a temporary rust protection when used on steel and other contaminations when used at temperature of 160° F. to 180° F.

Is extremely effective prior to Parkerizing or Bonderizing.

Have your MAC DERMID INCORPORATED Technical Service Engineer demonstrate these remarkable new compounds or write directly to us, stating your problem, for free technical data sheets.

Compounds and Equipment for Metal Finishing

Metex Zinc Stripper

Fast acting, hard hitting alkaline solution which thoroughly strips zinc from basis metals leaving stripped metal bright and free from smut. Will not embrittle steel nor etch the polished surface. Removes IRIDITE and CRONAK and other dichromate treatments while stripping zinc by simple immersion process. Equally effective for stripping hot dipped galvanized coatings.

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Positive new wetting agent for fast-positive pickling. Increases efficiency. Reduces acid concentration. Aids coverage and rinsing when used with IRIDITE and CRONAK solutions.

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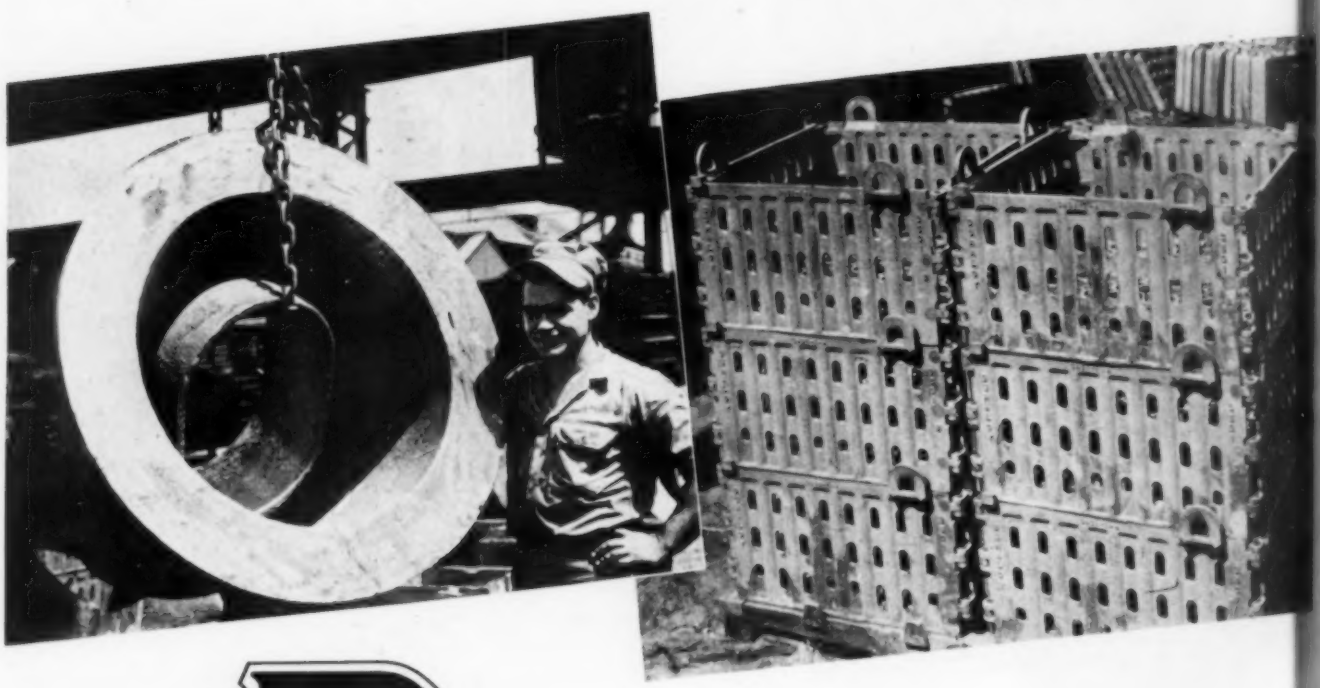
FUMES, FIRE, GRIT *and* CORROSION...



DURALOY *takes them all*

DURALOY high alloy castings are the operator's best bet for long service against heat, corroding attack, and abrasion materials.

As producers of chrome-iron and chrome-nickel castings since 1921, DURALOY metallurgists and foundry men have the experience, and facilities to do exceptional casting work, both static and centrifugal.

If you are bothered with too frequent replacement of castings because of heat, corrosion or wear, consult with DURALOY metallurgists.

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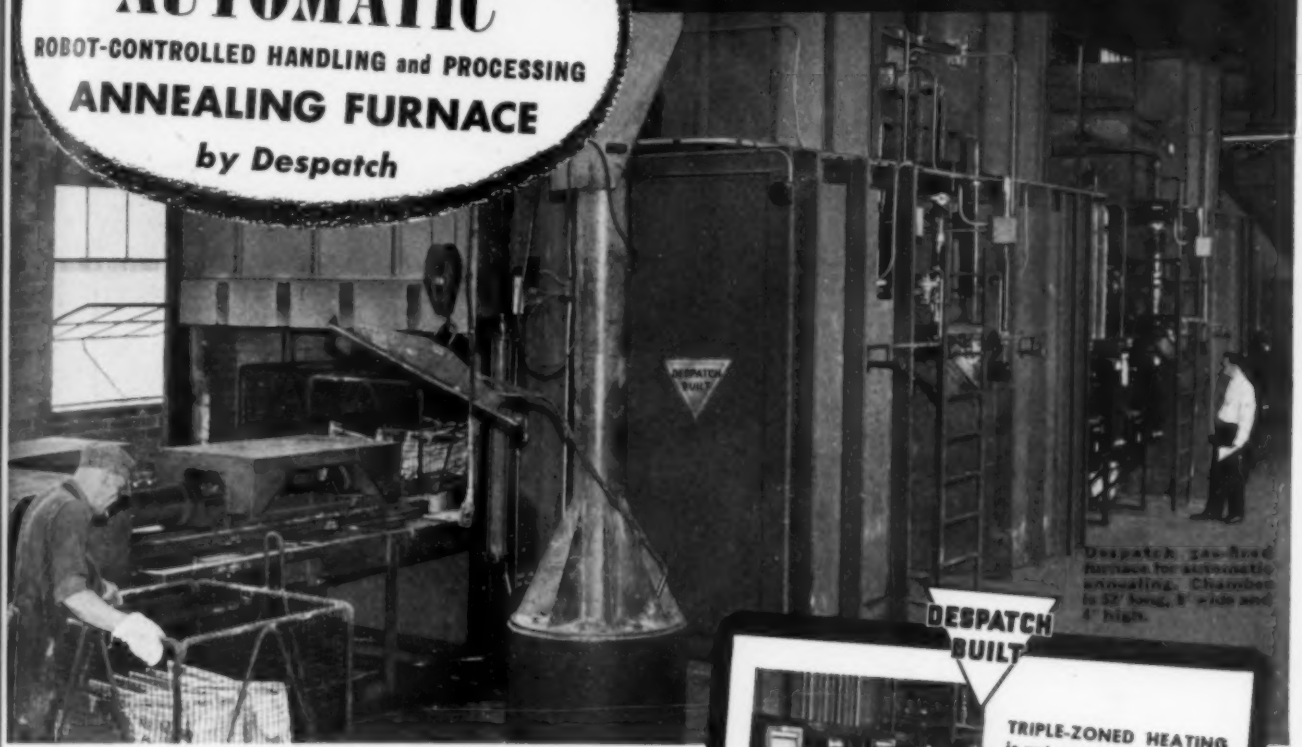
ROBOT-CONTROLLED HANDLING and PROCESSING

ANNEALING FURNACE

by Despatch

Another milestone in mechanization!



Requiring no manual effort whatever, save for placing load-baskets in front of chamber entrance, this Despatch "pusher type" furnace subcritically anneals 14,000 lbs. of alloy steel per hour on dual load-lines . . . and meets *all* treatment specifications!

This installation* is typical of Despatch success in building automatic-operating, highly mechanized furnaces to fit *any* industrial requirement.

Entire Operation is Time-Cycle Controlled

At predetermined intervals an "unloader" pulls a processed load from zoned-heated chamber while a "pusher" thrusts in new load at opposite end. Each load-line functions independently for additional flexibility.

All operations . . . controlled heating, handling of load-baskets, etc. . . . are *automatically* governed from a battery of time-cycle control panels. The furnace is a robot from A to Z!

AVAILABLE IN ANY SIZE are similar Despatch furnaces for your heat processing requirements, up to 2400° F. WRITE TODAY for complete details.

DESPATCH BUILT

TRIPLE-ZONED HEATING is automatically controlled from panel boards. Note straight line temperature control shown on recorder charts. Assures accurate processing to meet specifications.

CYCLING PANEL equipped with timer controls. Allows automatic, independent control of pushers, unloaders, etc., for handling 30 load-baskets, 15 on each line.

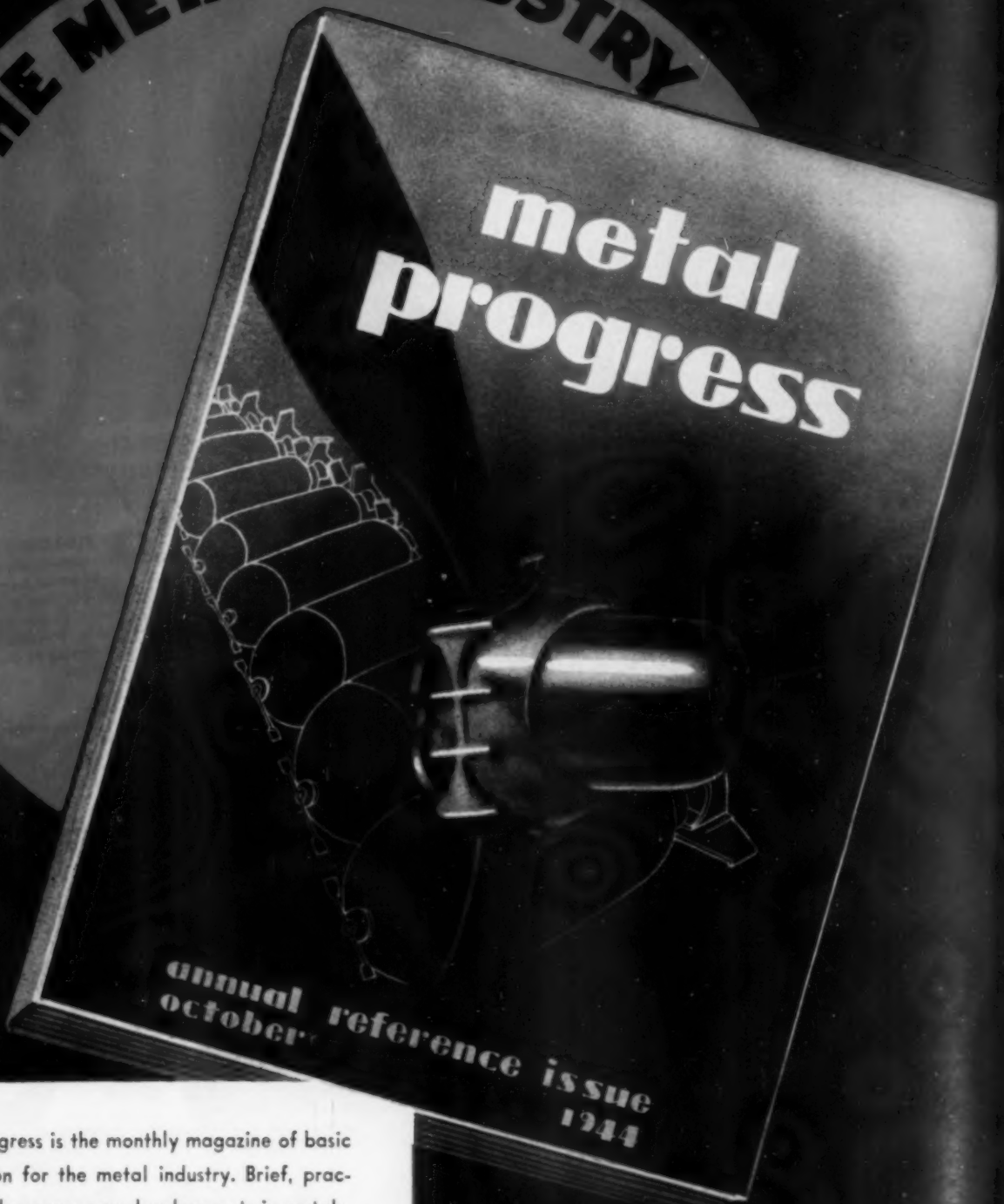
*A SECOND FURNACE like this is now being installed in the same aircraft plant.

DESPATCH OVEN COMPANY MINNEAPOLIS 14 MINNESOTA, U.S.A.

Stress Relief Furnace | Billet Heating Furnace | Platform-Loaded Furnace | Pit Type Furnace | Despatch Conveyor Furnace

BASIC

IN THE METAL INDUSTRY



Metal Progress is the monthly magazine of basic information for the metal industry. Brief, practical articles cover new developments in metals, their production, processing, fabrication and use . . . Facts essential to some 19,000 executives, engineers and production men—men who are your basic audience in any campaign covering this great industry . . . Start with Metal Progress in your schedule for the coming year.

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Also Publishers of **THE METALS REVI**

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Saves Machining

Saves Time and Money

Sizes closely parallel most requirements — saving time and material. Quality is high; Ampco Hollow Rod actually is replacing forged material in valve seats for aircraft engines — evidence of its clean, sound structure and excellent physical properties . . . This Ampco product is intended primarily for bushings, sleeves, leadscrew nuts, and similar machine parts. Write for new price list of Ampco extruded products.

AMPCO Reg. U.S. Pat. Off.

— processed in Ampco's 2275-ton extrusion mill, one of the many facilities and services which make Ampco Metal, Inc. a complete, self-contained source of copper-base alloy parts.

TURN THE PAGE

AW-32

Ampco Metal Parts made from extruded stock

All the inherent advantages of Ampco Metal—its exceptional resistance to wear, impact, fatigue, and corrosion—its specific properties as a series of engineered aluminum bronze alloys, held within close limits by rigid quality control — are available to you in all the forms by which metal is commonly worked. Ampco facilities include

Sand Casting	Annealing, Heat Treating
Centrifugal Casting	Precision Machining
Forging, Swaging, Rolling	Welding
Extrusion	Other Fabrication (spinning, bending, etc., etc.)

Ampco also offers you a specialized engineering and production "know-how" to convert your design into a practical manufacturing proposition. Ampco's nation-wide organization of field engineers is ready to assist you. Call on us. Write on your business letterhead for Engineering Data Sheet 125 and Ampco Metal Catalog.

Only from Ampco can you get *all* of these services and benefits *conveniently*:

1. Distinctive properties of resistance to wear, impact, fatigue, corrosion.
2. A series of engineered alloys — with physical properties to fit your application.
3. Quality control to hold these properties within narrow limits.
4. Diversified production facilities — coordinating in one place all the commonly used metalworking processes.
5. Engineering and production "know-how" to give you a practical manufacturing program.
6. A nation-wide organization of field engineers to assist you.
7. A record of proved performance in hundreds of leading makes of equipment.
8. A national reputation that makes Ampco Metal parts a sales asset.

. . . Specialists in engineering — production — finishing of copper-base alloy parts.

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The Metal without an Equal

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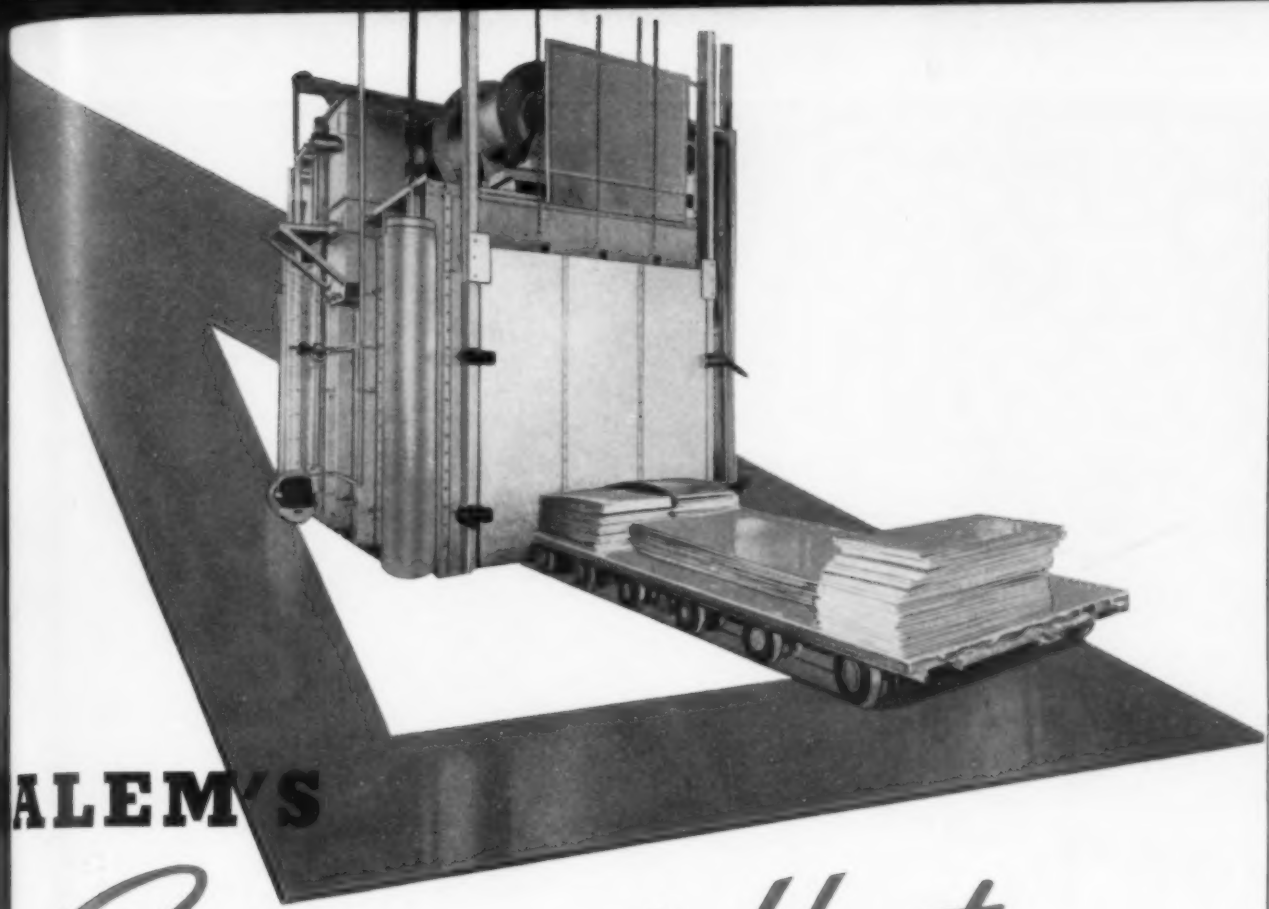

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APPLIED TO ALUMINUM!

A customer requested Salem to design a new type of low temperature furnace for heat treating aluminum sheets and plates.

Salem engineers came up with a unique method of convection heating, incorporating several new ideas. Result — the buyer has what he wants . . . uniform, consistent production with no remelting or reheating.

Salem builds all sizes and styles of heat treating furnaces for any fuel: batch, car, rotary, and many special types.

We design the equipment for specific production requirements of the individual customer, combining engineering with economics.

Our engineers call the Salem service — "Engineered Heat." Others tab it—Salem Ingenuity.

Check your 1945 heat treating requirements with Salem. Prompt attention to your heat treating inquiry.

SALEM **SALEM** OHIO

ENGINEERING CO.

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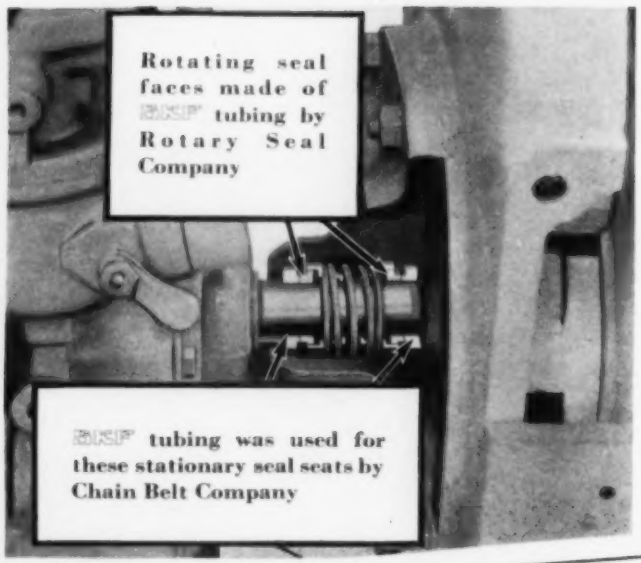
SKF

SEAMLESS STEEL TUBING

AVAILABLE

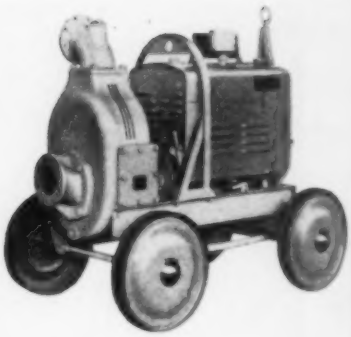
. . . as you need it
. . . when you need it
TO SUIT YOUR EXACT REQUIREMENTS

(SAE 52100) and ROUND BARS



Rotating seal faces made of SKF tubing by Rotary Seal Company

SKF tubing was used for these stationary seal seats by Chain Belt Company



SKF tubing insures long life of vital parts of Chain Belt pumps under tough operating conditions

ROTARY SEAL COMPANY AND CHAIN BELT COMPANY DO IT WITH SKF TUBING

If you want to count the ticks of the clock saved in machining, ask Rotary Seal and Chain Belt engineers. Chances are, they'll tell you, they run into many hours in a year's time . . . that SKF Seamless Steel Tubing not only stepped up their production, but material, machining and labor costs took a nose dive as well.

Available for immediate delivery:

a complete stock of SKF HIGH CARBON CHROME (SAE 52100) SEAMLESS STEEL TUBING and ROUND BARS:

TUBING -- *Approximately 300 sizes -- ranging from less than 1" O. D. to over 8½" O. D. with heavy and light wall thicknesses.*

BARS ---- *Ranging from $13/64$" to 6½" diameter; supplied in hot rolled, cold drawn, centerless ground or turned finish.*

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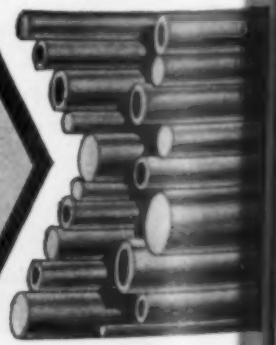
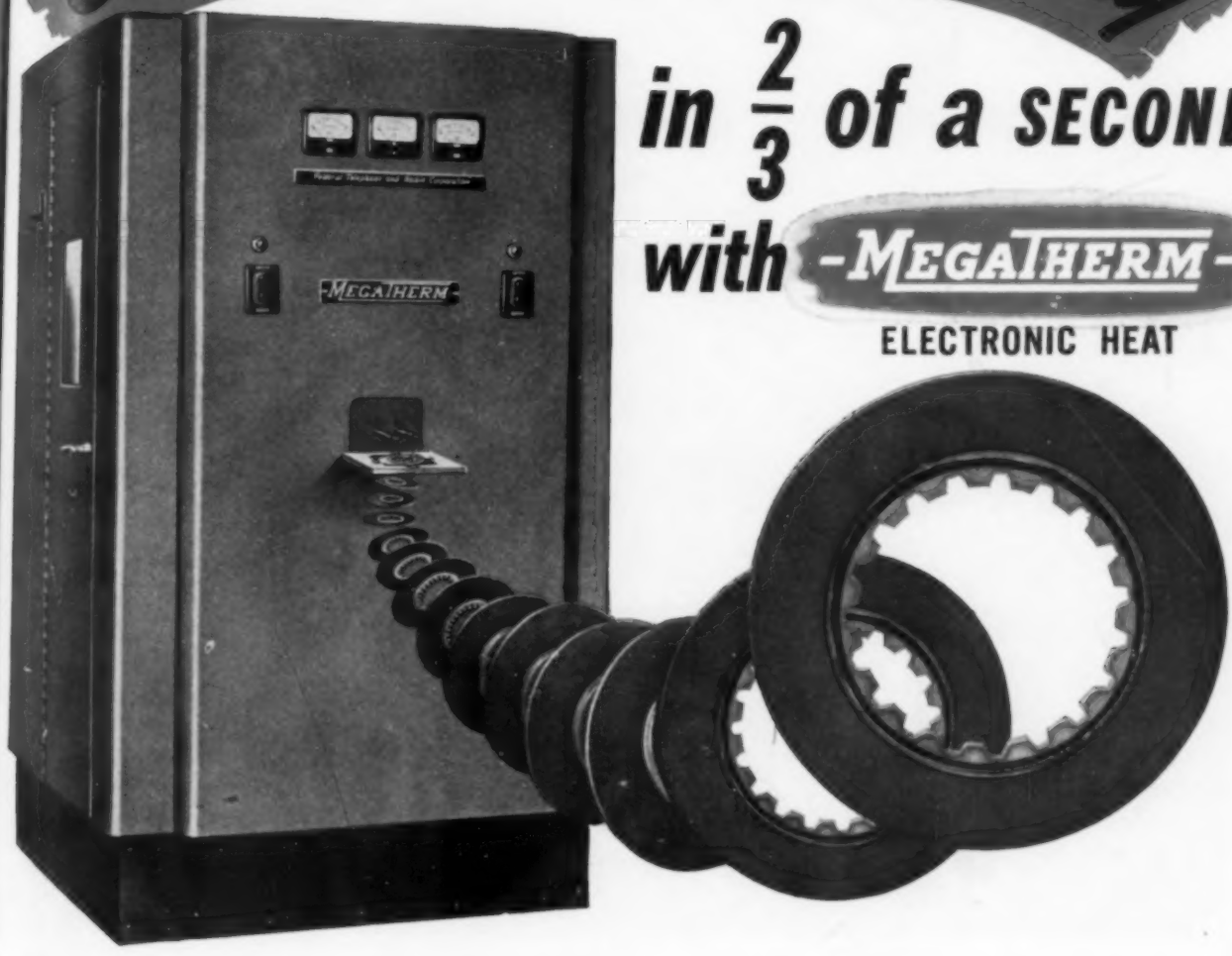


Exact Contour Hardening

in 2/3 of a SECOND

with -MEGATHERM-*

ELECTRONIC HEAT



Here's another difficult hardening job, done simply and quickly with Megatherm.

Exact contour hardening of the inner gear of these supercharger clutch discs was done in less than ⅔ of a second each.

These gears were hardened to a depth of .050", with the hardening closely following the tooth and root contour of the gear surface, without affecting the strength or ductility of the remaining metal. The unretouched photograph above tells the story.

To do this contour hardening a jig was built to support the disc so that its inner surface surrounded a two-turn induction coil, directly connected to the output terminals of the 25 kw Megatherm.

The Megatherm automatic timer limits the heat period to exactly ⅔ of a second, then operates a solenoid which trips the disc into an oil-quench bath.

Here is another example of Megatherm's adaptability to many hardening problems involving irregular and "hard-to-get-at" surfaces.

If you have a surface hardening problem . . . whether for wartime or peacetime application . . . consult Federal's Megatherm engineers for the answer or write for complete data.

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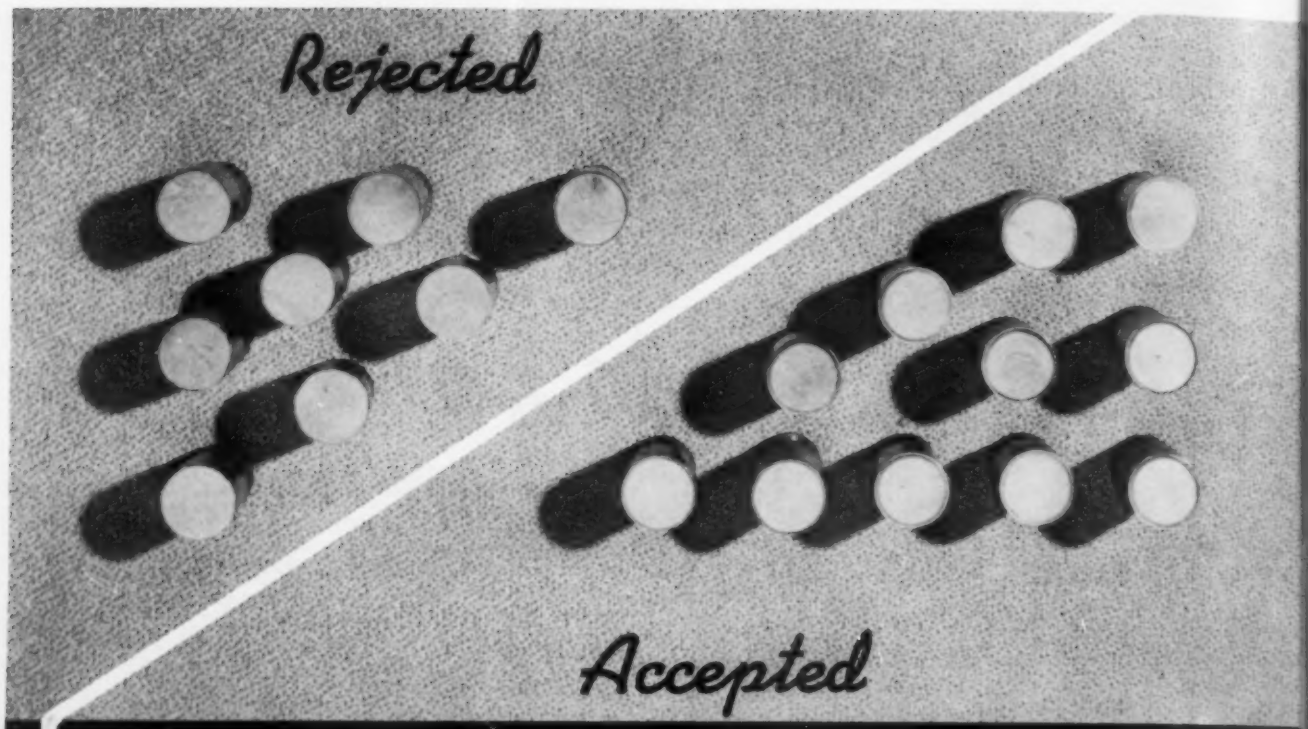

A PRACTICAL COMPARISON OF CASE DEPTH IN PRODUCTION, WITH THE DuMONT Cyclograph

These parts have a specified lower limit case depth of .025".

The DuMont Cyclograph sorts these parts into two groups: Group A, case depth less than .025"; Group B, case depth more than .025". This non-destructive, positive, 100% quality inspection has handled several hundred thousand such pieces to date, at a rate of 15,000 per day.

If you are vitally interested in checking case depth on production runs, the Cyclograph may provide that 100% inspection means on a wide variety of shapes and sizes of pieces.

Also, the Cyclograph grades and sorts according to analysis, structure, decarburization, plating or cladding thickness, internal stresses, etc., on ferrous and non-ferrous metals.

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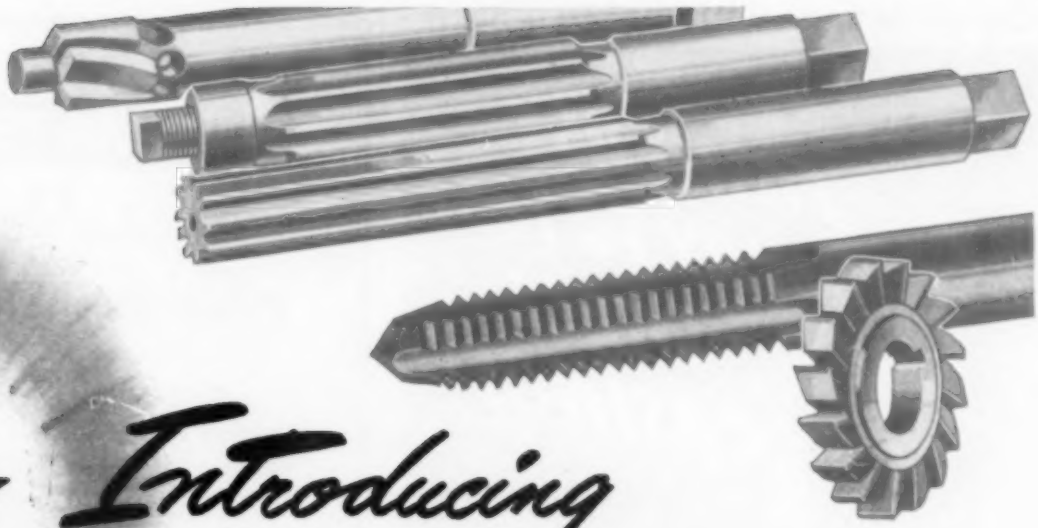

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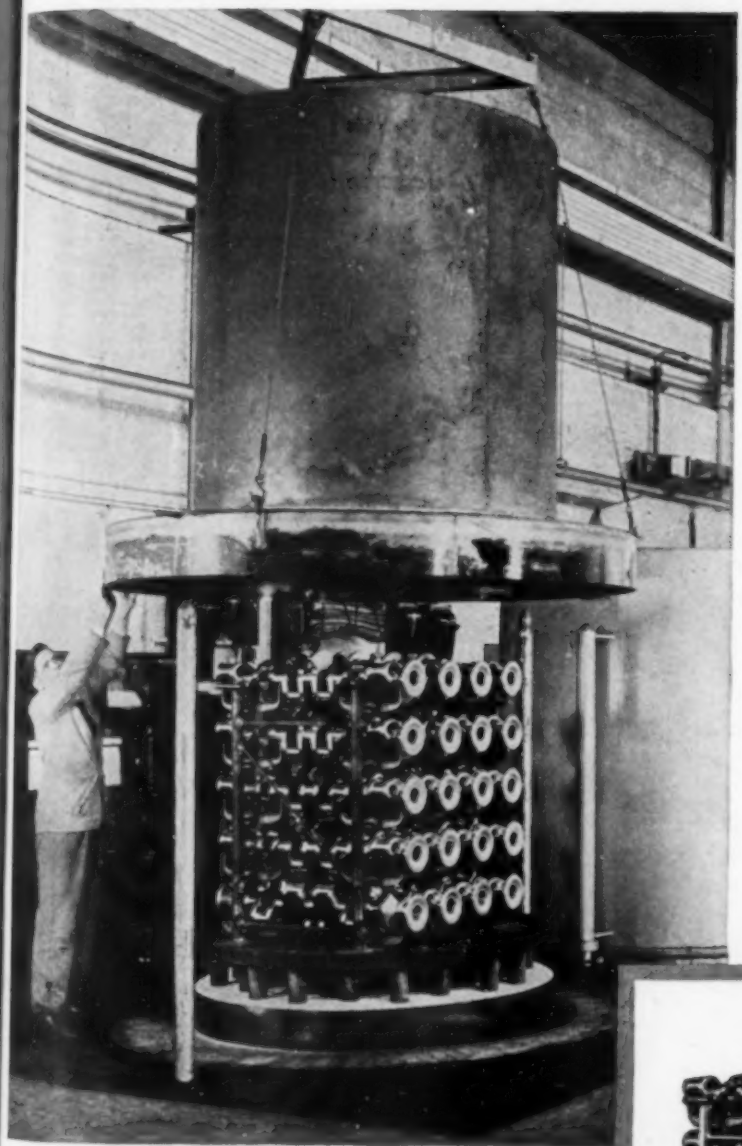
Packard reports: EXCELLENT RESULTS FROM INCONEL HOODS and RACKS in nitriding of Rolls-Royce crankshafts



Late in '41, Packard installed modern equipment for nitriding crankshafts for Rolls-Royce aircraft engines.

The hoods are made of Inconel sheet . . . welded *gas-tight* to confine the dissociated ammonia. The carrying racks are welded from Inconel tubing and bar.

Examined recently . . . after almost 2½ years of severe service . . . neither the hoods nor the racks show sign of deterioration.

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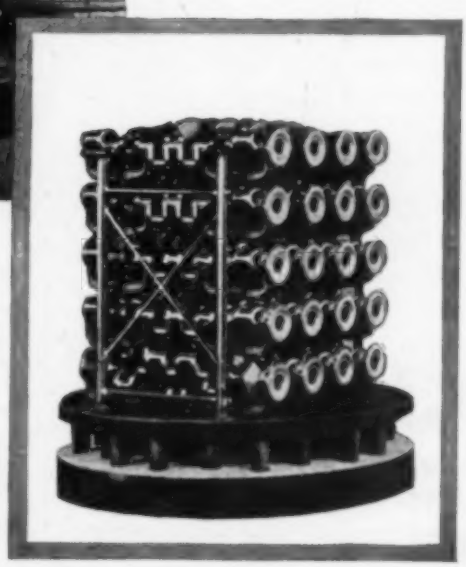

NITRIDING CRANKSHAFTS FOR ROLLS-ROYCE AIRCRAFT ENGINES. *The Inconel hoods and carrying racks are exposed to dissociated ammonia at 900° F. . . . give no evidence of deterioration from oxidation or scaling, or embrittlement. The welds are as sound as the parent metal.*

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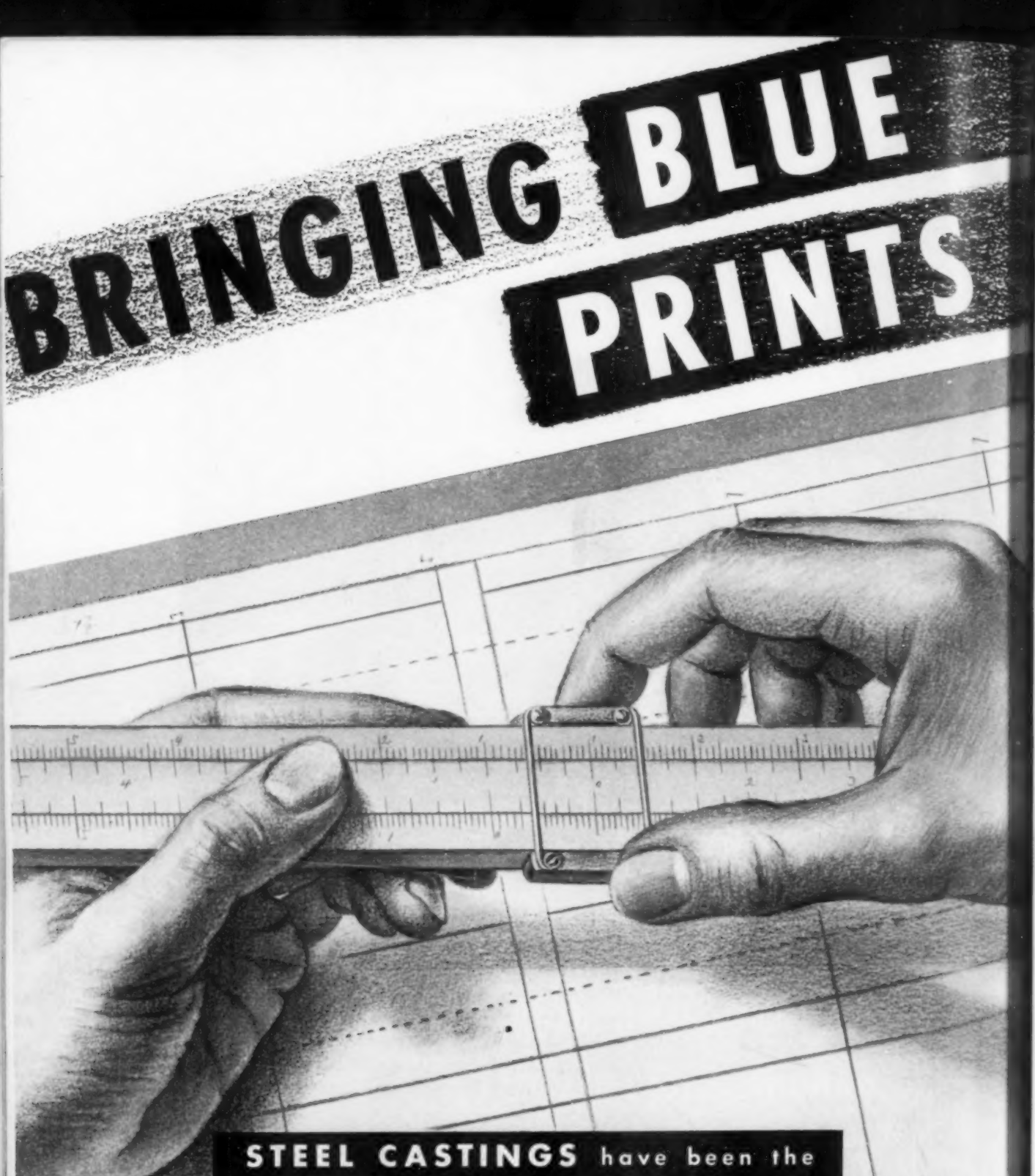

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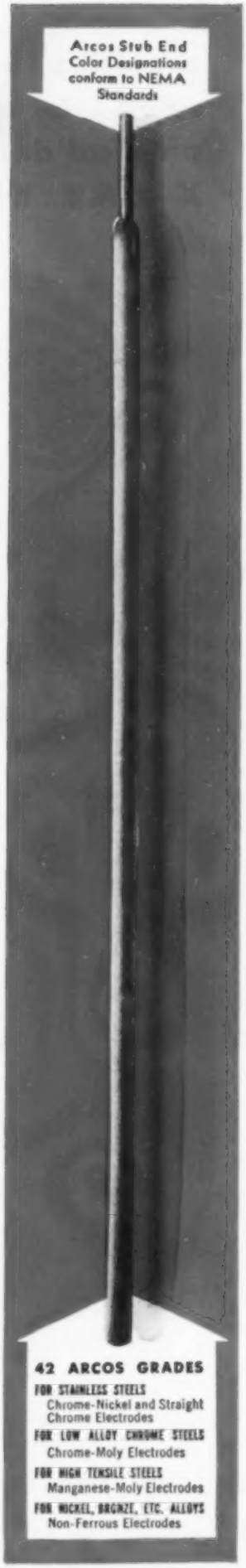
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42 ARCOS GRADES
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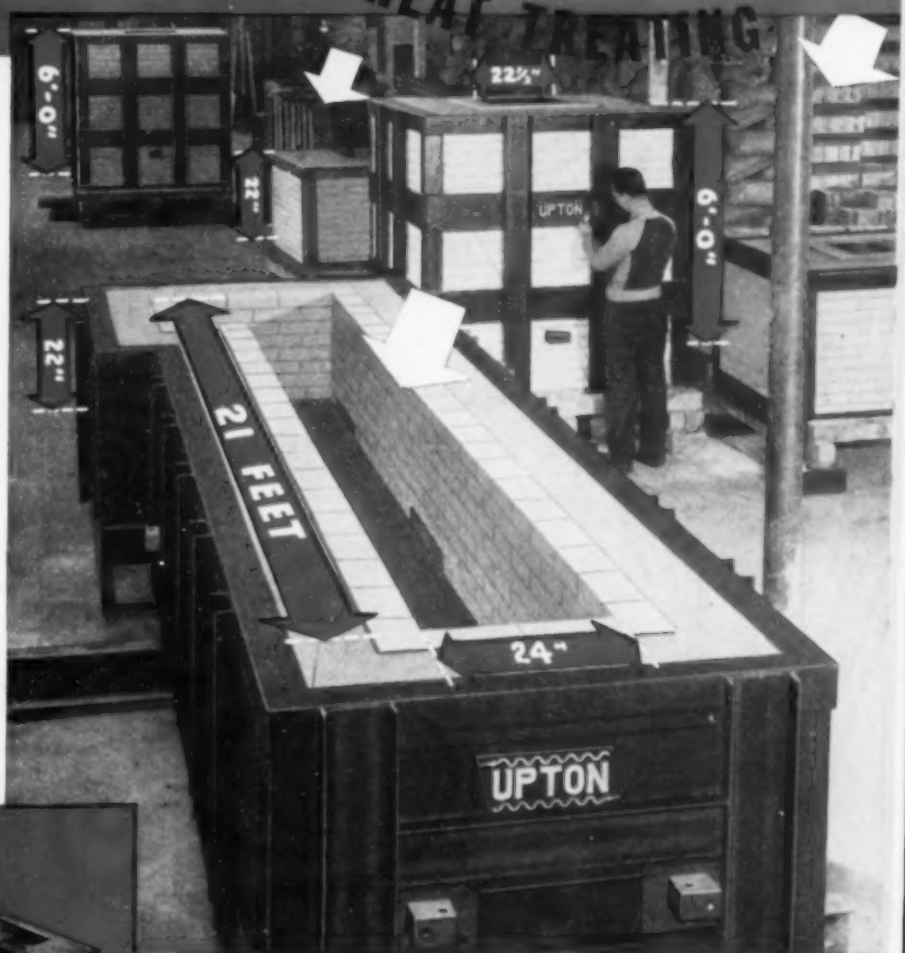

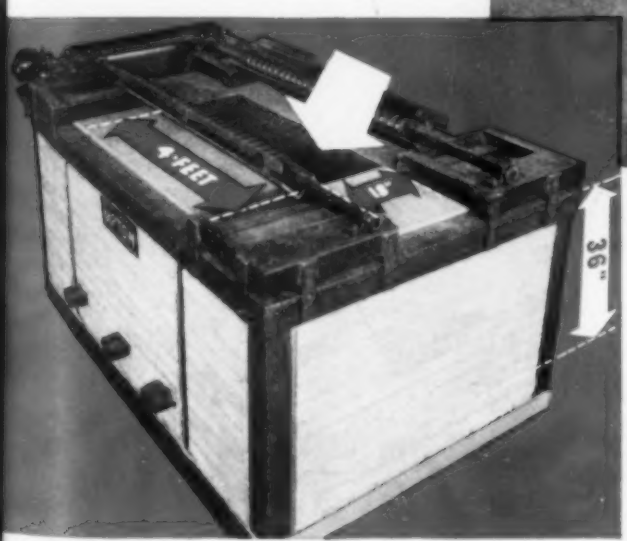

These furnaces nearing completion, indicate some of the sizes that are available in Upton Electric Salt Bath Furnaces. The long (21'-0") furnace in the foreground is for continuous anneal of brass cartridge cases. The other vertical furnaces are for High Speed and Moly Steel hardening. Other sizes are as readily available.

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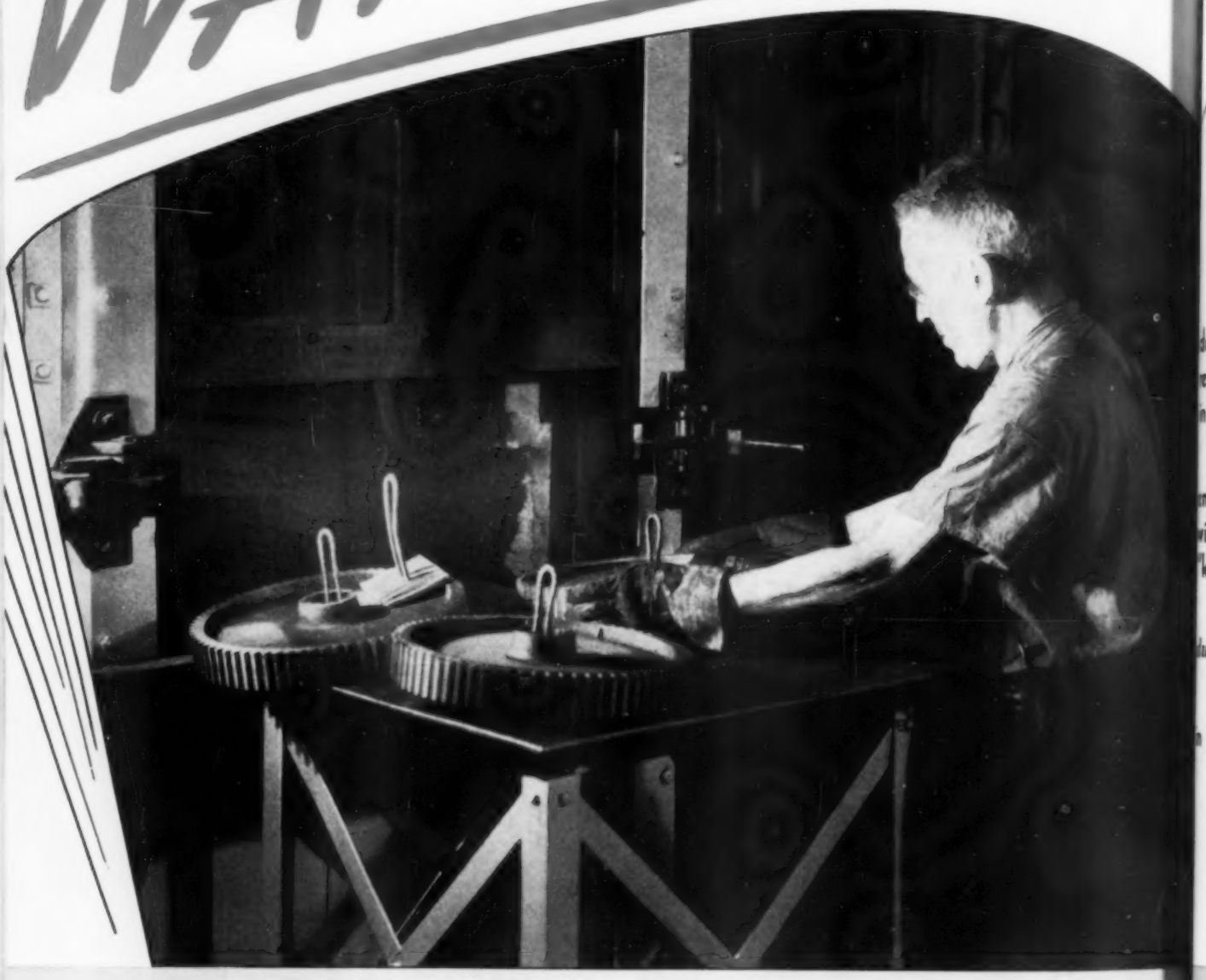

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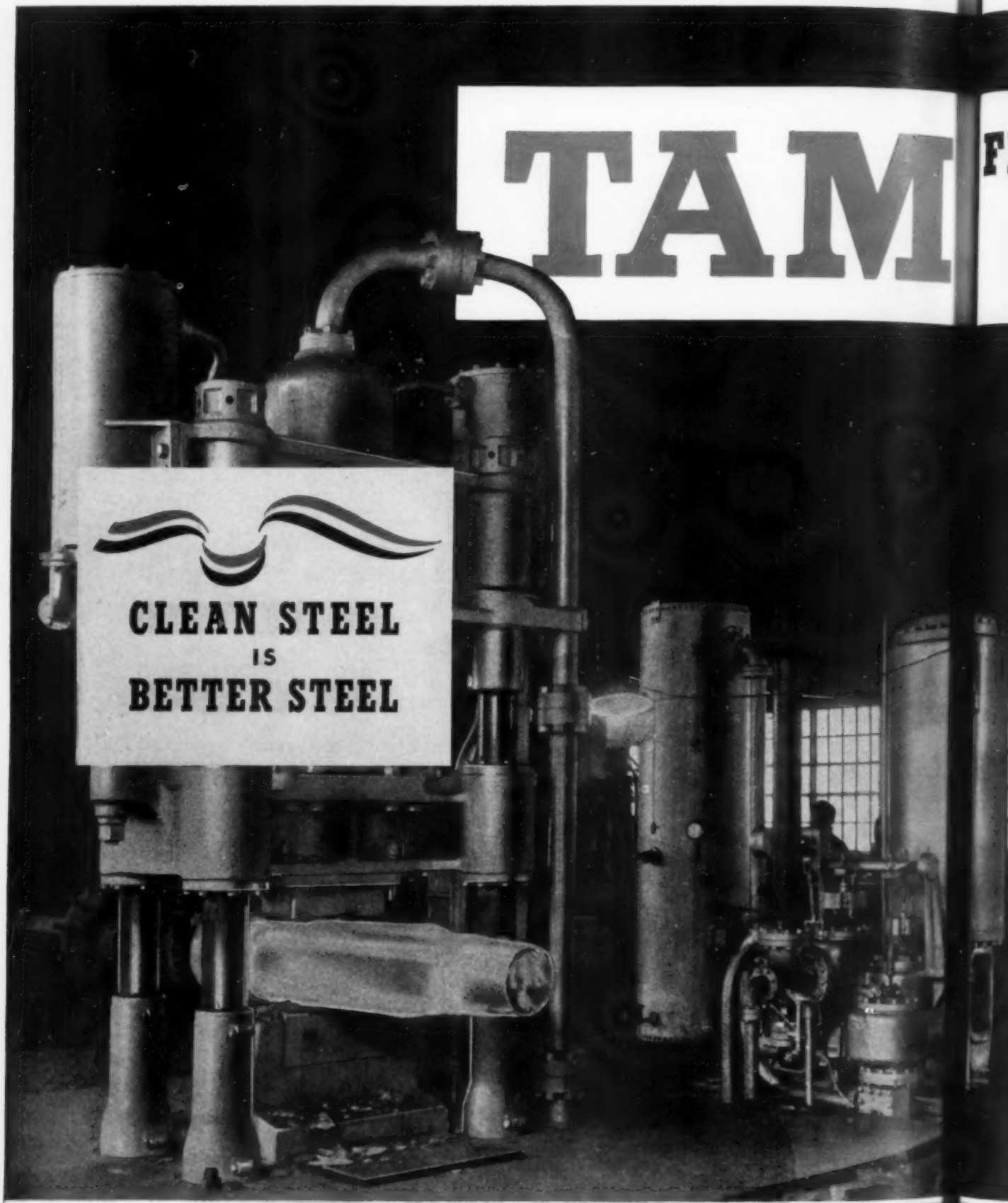

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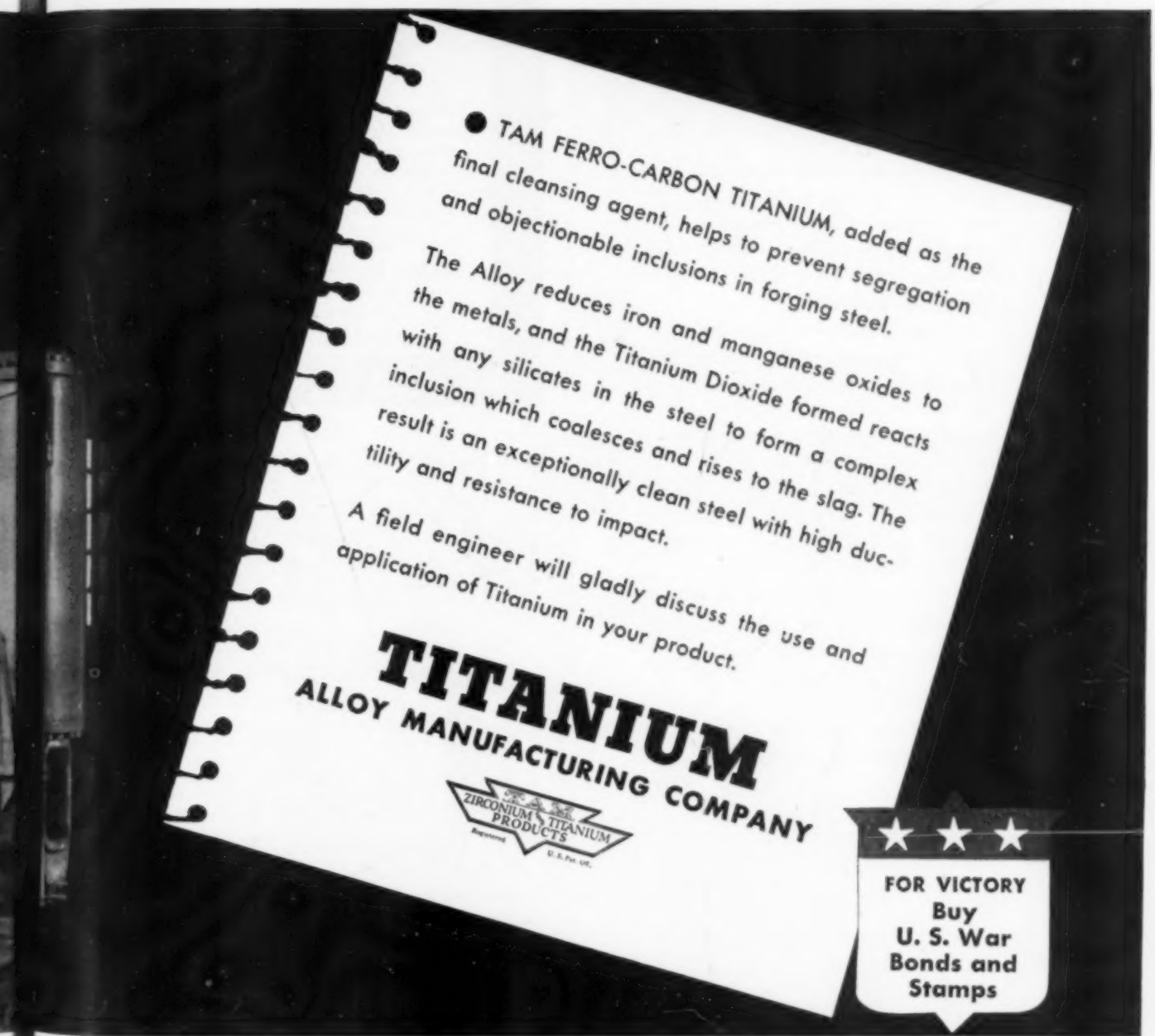
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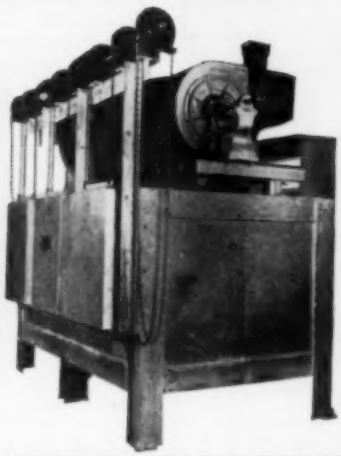

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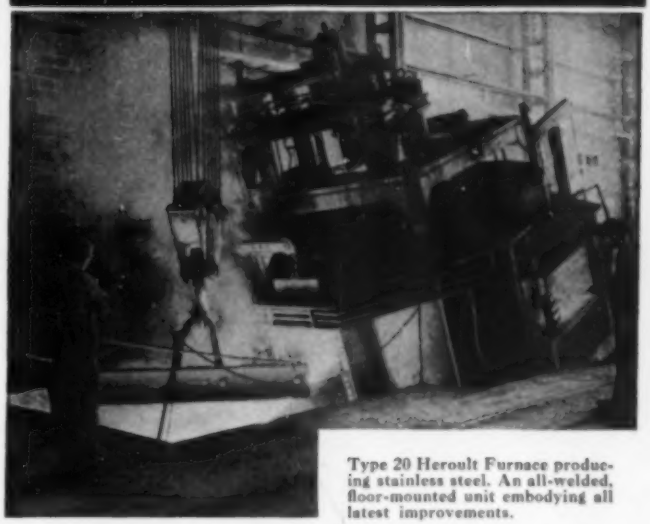

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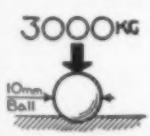

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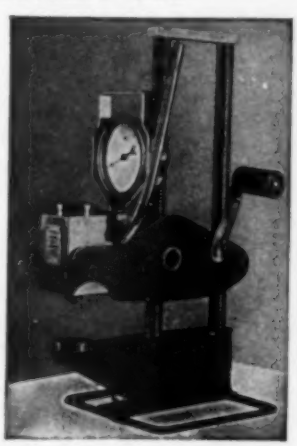

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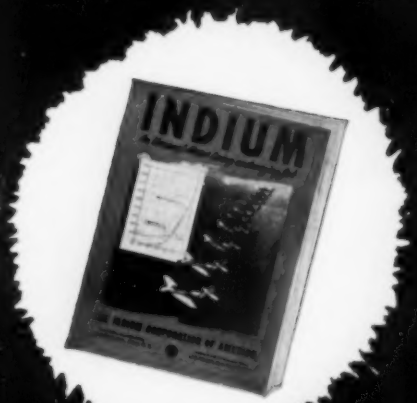

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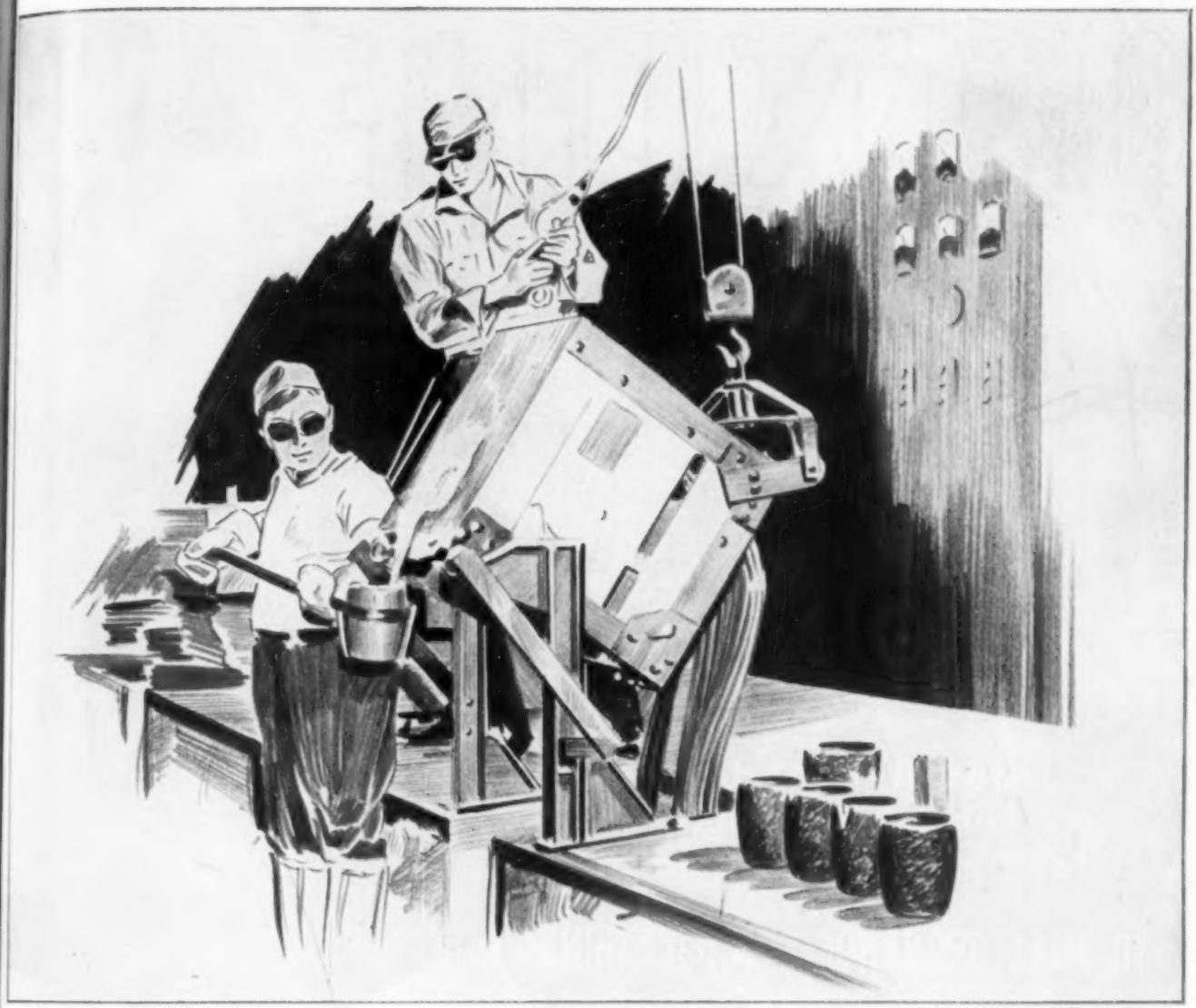

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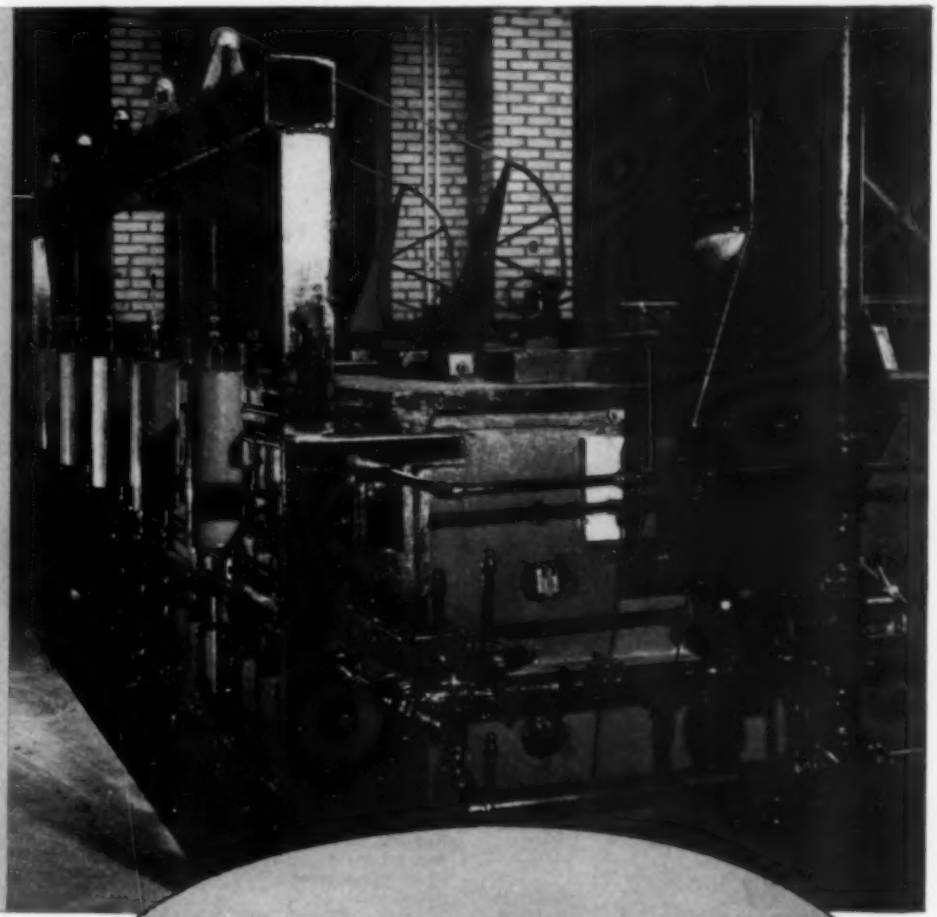

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Thurner Heat Treating Co. ....1348, 1[illegible]
Timken Roller Bearing Co., Steel & Tube Div. ....1[illegible]
Titanium Alloy Mfg. Co. ....1330, 1[illegible]
Trent Co., Harold E. ....1[illegible]
Tube Turns, Inc. ....1192A, 1192[illegible]

U. S. Reduction Co. ....1224[illegible]
United States Steel Corp. ....1[illegible]
United States Steel Export Co. ....1[illegible]
Union Carbide & Carbon Corp. ....1[illegible]
Unitcast Corp., Steel Casting Div. ....1334, 1[illegible]
Utility Electric Steel Foundry ....1334, 1[illegible]

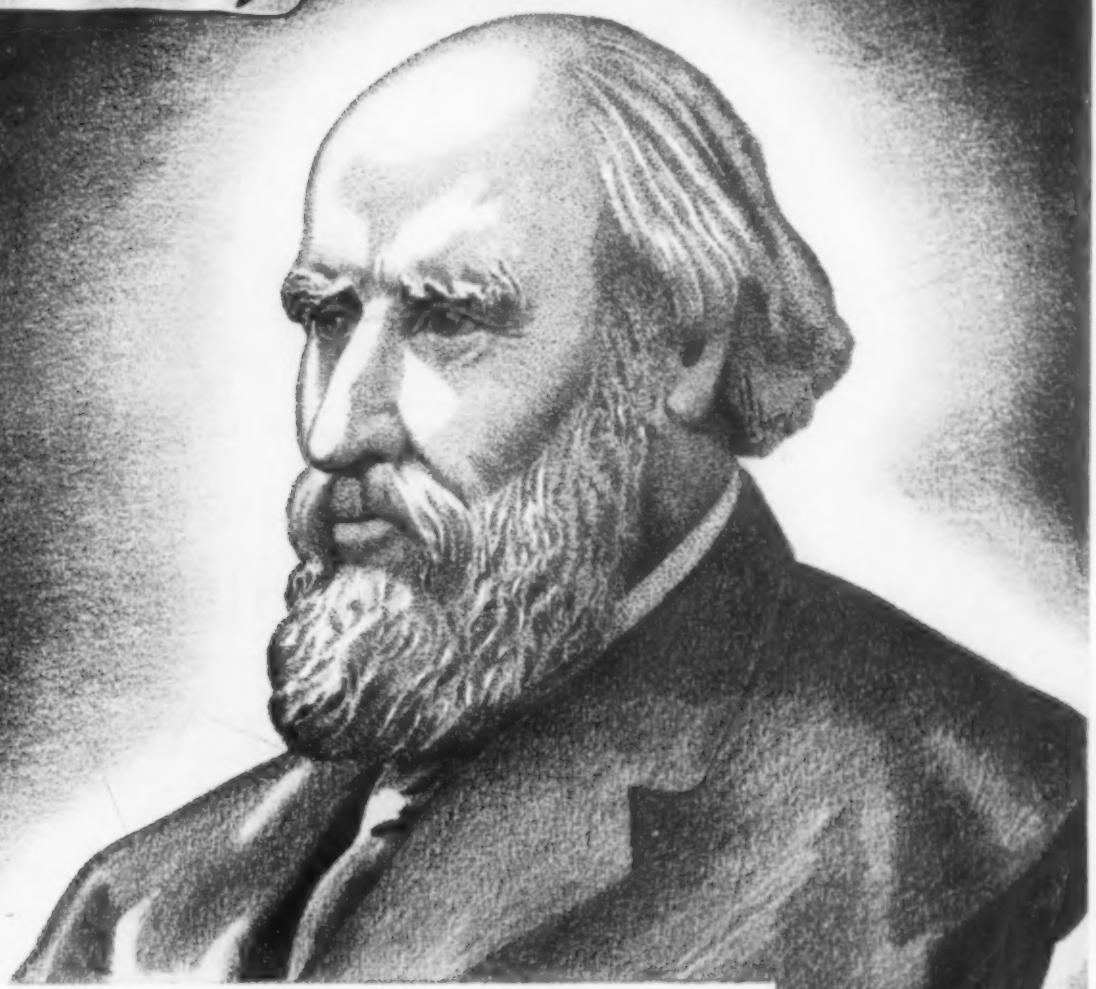
Wall-Colmonoy Corp. ....1[illegible]
Western Cartridge Co. ....1[illegible]
Western Gold & Platinum Works ....1[illegible]
Westinghouse Electric & Mfg. Co. ....1194, 1195, 1[illegible]
Wheelco Instruments Co. ....1[illegible]
Wheelock, Lovejoy & Co., Inc. ....1[illegible]
Wiedemann Machine Co. ....1348, 1[illegible]
Wilson Co., H. A. ....1[illegible]
Wilson Enginering Co., Inc., Lee ....1[illegible]
Wilson Mechanical Instrument Co., Inc. ....1[illegible]
Wyckoff Steel Co. ....1[illegible]

Youngstown Sheet & Tube Co. ....1[illegible]
Youngstown Welding & Engineering Co. ....1[illegible]

Ziv Steel & Wire Co. ....1[illegible]

CLEVELAND TOWER PRESS

SYMBOL of PIONEER COURAGE



James J. Hill, empire builder of the West, attributed his success to his motto; "Work, hard work, intelligent work and then more work." Born to see man subdue the wilderness, to see victory over primitive forces of nature, Hill pioneered the instrument responsible for that achievement—the railroad.

Hill's railroad to the Pacific coast encouraged farming along the tracks; settlements grew into states—lumbering, coal and ore mining flourished; Hill had blazed the trail that tapped the great resources of the West.

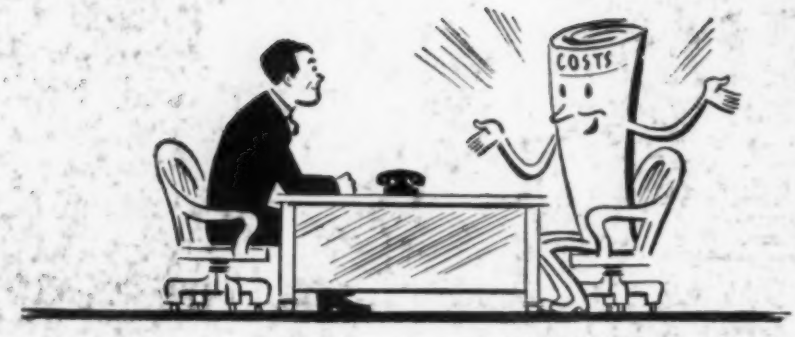
James J. Hill

THE ELECTRO-ALLOYS COMPANY
ELYRIA, OHIO.

MAKERS OF

X-RAY Inspected Thermalloy Brake Shoe

HEAT AND CORROSION RESISTANT ... CASTINGS



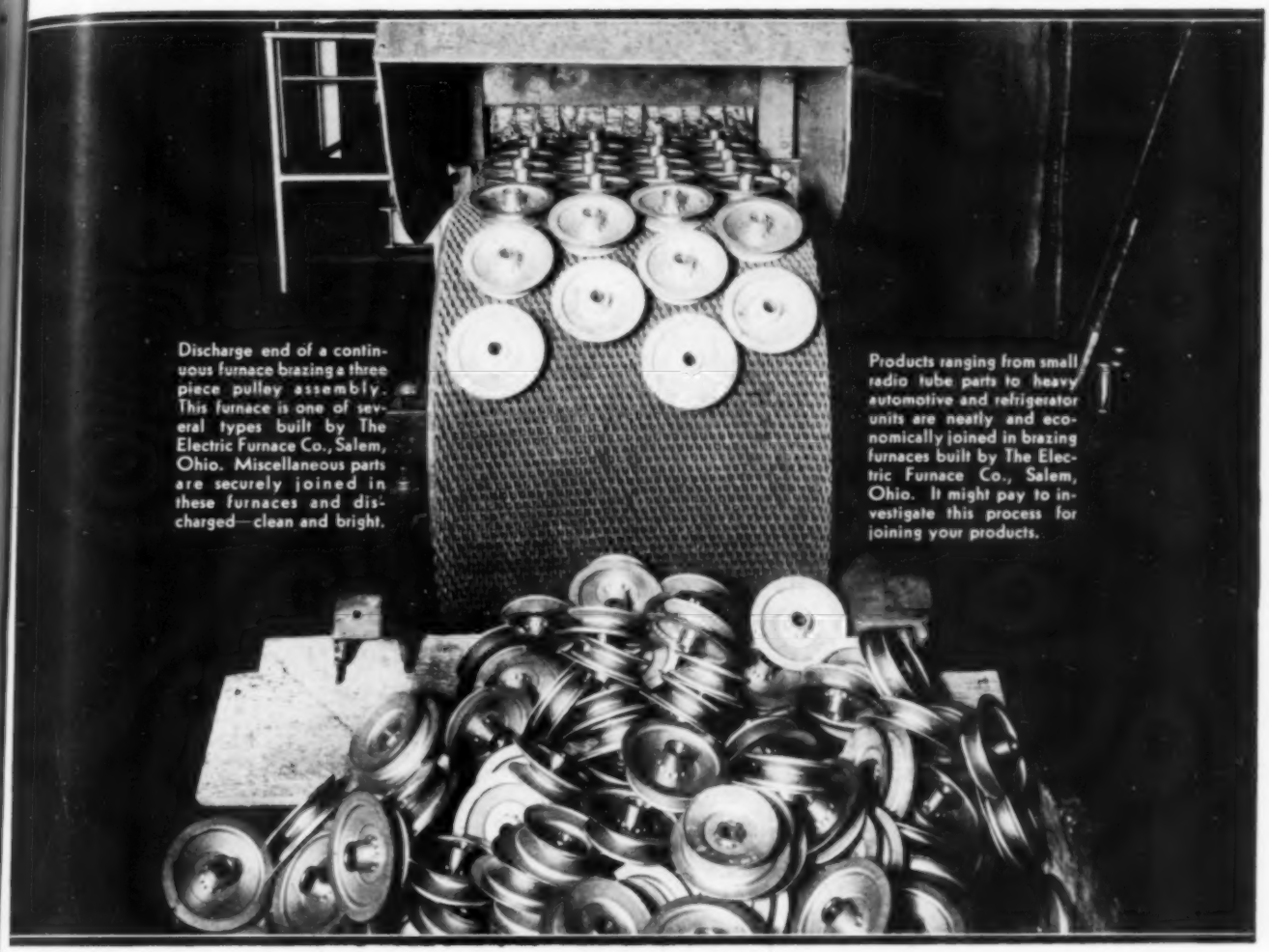
Your Cost Sheet will tell you the difference

—between electronic and mechanical control and possibly the difference between profit and loss in the inevitable battle of competition. The speed and accuracy of electronic control is unequalled. Rejects are eliminated—quantity and quality of production increased and fuel consumption reduced. To the unsurpassable advantages of electronics Wheelco has pioneered and added other features, which when combined in the Wheelco Capacitrol afford the ultimate in control instrument versatility and performance for indicating and controlling power, voltage, current, pressure, speed and similar quantities and conditions. To this Wheelco achievement—*the original electronic controller*—you can have Proportioning Control integrally added. It's the instrument that revolutionized an industry—it will revolutionize your control problems.

WHEELCO INSTRUMENTS COMPANY

835 West Harrison Street, Chicago 7, Illinois

Creators of "Electronic Principle" Temperature Controls



Discharge end of a continuous furnace brazing a three piece pulley assembly. This furnace is one of several types built by The Electric Furnace Co., Salem, Ohio. Miscellaneous parts are securely joined in these furnaces and discharged—clean and bright.

Products ranging from small radio tube parts to heavy automotive and refrigerator units are neatly and economically joined in brazing furnaces built by The Electric Furnace Co., Salem, Ohio. It might pay to investigate this process for joining your products.

The Completed Assemblies are Discharged

Securely Joined, Bright, Continuously

. . . from EF Brazing Furnaces

The above shows the result of a laboratory test on an automobile fan pulley in which the hub was brazed to the web. The complete pulley was placed in a press and pressure applied. The steel web broke but the brazed joint held securely.

Products difficult or expensive to make in one piece can be made in several pieces and joined—thus not only reducing the cost but actually improving the quality and appearance.

Products requiring several stampings joined or requiring screw machine parts, forgings and stampings to complete the unit, can be neatly and economically joined right in your production line.

Strong, leak-proof joints are made and the completed unit is discharged from the furnace—clean and bright.

Any number of joints in the same product or any number of pieces can be joined at one time.

The most intricate parts or assemblies are joined and the joints are as strong, and in some cases even stronger than the original parts.

Investigate This Process for Joining Your Aluminum, Brass, Copper or Steel Parts.

We will be glad to give you complete information, put samples of your products through one of our furnaces to show you the results you can expect, and give you an estimate on the cost of the equipment to handle your product; together with operating cost, etc.

Send for printed matter showing various types of EF brazing furnaces.

The Electric Furnace Co., Salem, Ohio

Gas Fired, Oil Fired and Electric Furnaces—For Any Process, Product or Production

If Your Rejections are High Check Back to the Ingot

SO MANY variables enter into the fabrication of steel parts that we can't get completely away from rejects of semi-finished and finished material. But we can reduce the percentage of rejects, in fact completely eliminate those due to unsound and highly segregated steel.

We must begin with a sound ingot, because any pipe or excessive segregation in the ingot is inevitably carried thru to the final product.

Study the three ingots pictured. All are from the same heat of steel, yet there is no assurance of either soundness or homogeneity in any portion of the big-end-down ingot, while the hot-topped big-end-up ingot is both sound and relatively homogeneous throughout the entire body portion.

The economic loss entailed in rejections of semi-finished and finished parts is enormous. The waste involved in remelting the scrap alone is great, but when we take into consideration the cost of the machining and fabrication that often precedes the finding of the defects, the loss is staggering.

So we suggest that when rejections in your plant run beyond the few percent that may be considered unavoidable, you investigate the type mold that has been used in producing the steel. The chances are a hundred to one that you will find that the steel has been cast in molds of faulty design.

Product of a big-end-up mold of good proportions equipped with a suitable shrinkhead casing. Yields in sound homogeneous blooms or billets are as high as **80%** to **85%** of the ingot weight.

Product of a big-end-up mold of suitable proportions for sound homogeneous structure. Because no shrinkhead casing was used, however, the piped portion of the ingot is excessive. The available net yield in sound product is approximately **65%**.

Product of a big-end-down mold. The walls of the molds were sufficiently thick, and there was a minimum of taper . . . yet the net yield in pipe-free blooms is only approximately **50%** of the gross ingot weight and most of that is highly segregated.

Mr. Gathmann's book, "*The Ingot Phase of Steel Production*," lists the causes of many types of defects in steel products. If you do not already have a copy, we'll be glad to send one to you.

The Gathmann Engineering Company, Baltimore 28, Maryland.

GATHMANN *Big-End-Up*